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Correspondence.—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

Books.—We will forward by express, at publisher's lowest rates, any book—scientific or otherwise—to any address in the United States or Canada. We would suggest to our patrons that to avoid the risk and expense consequent on sending us the money (we do not send books C. O. D.), that orders for books be sent us through the Purchasing Department of the American Express Company.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

First Annual Meeting, American Gas Institute.

AMERICAN GAS INSTITUTE,
OFFICE OF THE SECRETARY,
NEW ALBANY, IND., Aug. 27, 1906.

The first annual meeting of the American Gas Institute, composed of the merger of the Ohio, the American and Western Gas Associations, will be held in the Auditorium Hotel, Chicago, Ills., Oct. 17th, 18th and 19th, 1906, and will be called to order by Mr. B. W. Perkins, Altoona, Pa., President of the Ohio Gas Association, who has been selected as presiding officer.

The Auditorium Hotel offers rates to delegates as follows:

Single rooms	$2.00 per day and up.
Two in a room	3.00 per day and up.
Single room with bath	3.50 per day and up.
Double, or two in a room with bath	5.00 per day and up.

Those expecting to attend the Convention are requested to secure rooms in advance of the meeting.

The following Passenger Associations have granted reduced rates on the certificate plan of 1½ fare for the round trip, plus 25 cents for each railroad certificate vised by the representative of the Passenger Associations, who will indorse the certificates: Central Passenger Association, Western Passenger Association, Trunk Line Association, Eastern Canadian Passenger Association, South Western Passenger Association, South Eastern Passenger Association, New England Passenger Association, excepting the Eastern Steamship Company.

These Associations include all the territory of the United States, as far West as Colorado.

Membership blanks have been sent to all of the members of the three above Associations.

It is requested that members avail themselves of the opportunity to become charter members at the very earliest moment, insomuch as 60 days has been decided as the limit for acceptance.

Acknowledgments of the receipts of applications have been mailed to all of those who have forwarded their application to the Acting Secretary. Failure to receive such acknowledgment is indicative that your application for membership has not been received. The Acting Secretary urges upon every person, who wishes to become a charter member, that they lose no time in sending in their application. The qualification for membership is as follows:

From Section 8 of the Constitution.—"Charter members shall be such of the present membership of the American, Ohio or Western Gas Associations as shall be certified by the officers of the same to the Directors of the Institute as qualified respectively for Active, Junior or Associate membership, provided, that to become a charter member it shall be necessary for each person so certified to make application to the Directors of the Institute within a period of 60 days after notice has been sent him of the formation of the Institute."

In the judgment of the joint committee, appointed by the American, Ohio and Western Gas Associations to organize the American Gas Institute, no person delinquent for dues in either of the above Associa-

LIBRARY OF CONGRESS SMITHSONIAN DEPOSIT

tions shall be eligible for membership in American Gas Institute until such delinquencies are paid.

From Section 5 of Constitution.—"To be eligible to Active Membership, a person must be at least 26 years of age, and be an officer or other employee of a gas company, or a consulting gas engineer, or an employee of a consulting gas engineer. He must be competent to act efficiently as the manager of a department of a gas company's business, and must have his chief interest in the gas business directly connected with the manufacture, sale or utilization of gas, and not the manufacture or sale of apparatus or appliances used by gas companies."

From Section 6 of Constitution.—"To be eligible as a Junior Member, a person must be over 20 years of age and be in the employ of a gas company, or of consulting gas engineer, and must be qualified either by experience or education to hold a responsible position under such employers."

From Section 7 of Constitution.—"To be eligible as an Associate Member, a person must be engaged in a pursuit which constitutes a branch of gas engineering, or to be otherwise qualified to assist in promoting the objects of the Institute."

All charter members are exempt from membership fees. The annual dues, however, are payable in advance as soon as the permanent organization of the Institute is effected.

For those who are not members in good standing, in either the Ohio, American or Western Associations, and who are qualified to become members, the following membership fee, including the first year's dues will be charged:

Active membership	$25
Associate membership	25
Junior membership	10

Annual Dues.

Active membership	$10
Associate membership	10
Junior membership	5

A banquet will be provided for the Association members under the usual conditions, which have heretofore prevailed, each member attending paying an amount to be determined upon. The details as yet are not completed.

I would request again upon the members of the Ohio, American and Western Associations, that they attend to the notice received from the undersigned in reference to sending in their application.

The undersigned will be pleased to answer all communications in reference to the meeting, and to send membership applications to any not-eligible for charter membership, who may wish to become members of the American Gas Institute.

JAMES W. DUNBAR,
Acting Secretary.

[OFFICIAL NOTICE.]

Wrinkle Department, American Gas Institute.

Please note that subscriptions to the Wrinkle Department will be received up to, and including, October 1st, 1906, on which date the 1906 edition will close.

Drawings, photographs, sketches and descriptions of any device, formulæ, or methods for accomplishing objects pertaining to the gas business, are respectfully solicited.

Thanking you in advance for contributing promptly. Yours truly,

W. E. STEINWEDELL,
719 Citizens Building,
Cleveland, O.

B. MCADAM,
Milwaukee Gas Light Co.,
Milwaukee, Wis.

BRIEFLY TOLD.

JUDGE GIEGERICH'S DECISION.—On the 6th inst., Judge Giegerich, of the Supreme Court, having listened to the testimony or pleadings of the petitioners, who sought an order for readjustment in the case of one Dionegi Rebecchi against the Consolidated Gas Company, of New York, denied the petition. In that case a peremptory writ of mandamus was issued, which writ ordered the Company to supply gas to Rebecchi at the rate of 80 cents per 1,000 cubic feet, as provided in the applying statute. The Company's pleaders contended that, as the statute itself was in process of adjudication, and that until such process was completed, as the carrying out thereof would mean confiscation of its property without due process of law, the Company was entitled to charge the former prevailing rate of $1 per 1,000 cubic feet. Justice Giegerich held that an unsupported assertion of such nature was not sufficient to suspend the operation of the statute, which must remain the standard of practice until otherwise legally decreed. Among other paragraphs in the decision the following are written: "* * * To accomplish that effect the defendant should allege facts sufficient for the Court to determine whether the legal inference of inadequacy of return is well supported or not. The Court has a right to know what the facts are, that it may judge whether the legal inferences are well drawn. * * * I am satisfied in this case, however, that in order to avoid and suspend the operation of a statute like the present and defeat an application for a peremptory writ of mandamus, the defendant should be required to be more specific in its assertions and present to the Court something more clearly in the nature of facts and not so open to the criticism of being mere inference or conclusions; in other words, to show that there is a real issue of facts in the case." On the whole, the decision is one rather mistily involved, so far as diction goes; but it may not be truthfully denied that in import it certainly means the Consolidated Company may not charge in excess of 80 cents per 1,000 cubic feet in the interim of a final decision by the Supreme Court of the United States respecting whether or not the legislative rate is an equitable and just one.

Another echo in the city gas rate case is found in a decision by Justice Giegerich in the case of somebody *vs.* the Northern Union Gas Company, operating in the northern or Bronx district of New York city. The Company had adjusted its slot meters so as to yield 310 cubic feet of gas for 25 cents, but some consumers thought the last pennyweight of flesh should be given them and so asked that 312½ cubic feet be furnished for the quarter dollar—the 80-cent law, of course, governing. The decision was concise, in fact, curt, for it was decreed that the adjustment to 310 cubic feet was "sufficiently accurate."

DEATH OF MR. CLARENCE K. WOOSTER.—The tragic death of Mr. Clarence K. Wooster, who while temporarily insane committed suicide the morning of the 9th inst., in his home in Chicago, will be sincerely regretted. Deceased, who was born in Essex, Conn., May 21, 1857, came to Chicago in 1888, was prominently identified with the syndicate that eventually financed and constructed the works of the Equitable Gas Company, of Chicago, and when that concern was finally merged into the present corporation of the Peoples Gas Light and Coke Company (in 1899), he was elected its Third Vice-President. Mr. Wooster was a man of very genial personality, and his dementia (he was beyond a doubt not metally responsible for the act that termmated his life) was surely caused by a sunstroke that prostrated him in the severe hot spell of mid-August last.

NOTES.—

THE Western Maryland Gas Company, of Allegany county, Md., has been incorporated by Messrs. Forman, H. Schreiber, J. D. Northrop, F. M. Robey, Mortimer Church and Roderick Clary. It is capitalized in $20,000.

"R. B. W.," writing under date of the 8th inst., says that the display made by the Evansville (Ind.) Gas and Electric Light Company was really the feature of the Labor Day parade in Evansville. The Company had 5 well-equipped "floats" in line.

JUDGE LACOMBE granted the application of counsel for the Consolidated Gas Company for an extension of time in which to present its main evidence before the Special Master of the United States Circuit Court, Arthur H. Masten. It was thought that the Company's evidence would be all in by Saturday last.

MR. C. F. CATTELL, of West Chester, Pa., is in charge of the construction of the plant that is being put in to supply the residents of the contiguous boroughs of Avondale, West Grove and Kennett Square, Pa. If we mistake not, the plant proper will be located in Avondale.

THE fourth largest taxpayer on the rolls of the city of Lowell, Mass., is the Lowell Gas Company, whose payment on tax accounts this year amounts to $33,479.

THE latest ukase in respect of public lighting supply in Boston, Mass., is as follows:

"*Ordered*, That the Schoolhouse Custodian be instructed to proceed forthwith to obtain and record a reading of all gas and electric meters in the various school buildings, and thereafter to compare such meter readings with the monthly bills rendered for gas and electricity; and that he also call the attention of the janitors to the importance of exercising strict economy in the consumption of gas and electricity."

[Prepared for the JOURNAL.]

The Protection of a Large System of Mains.

By MR WALTON FORSTALL.

The average citizen and taxpayer, especially one living in a small town, believes that, with proper foresight on the part of the civic authorities and of the public service companies, all necessary underground structures can be placed in a street prior to its paving or repaving, so as to avoid any subsequent disturbance of the new surface for which the citizen aforesaid has paid an assessment and which he, therefore, regards as the veritable apple of his eye. As any gas man knows, the citizen's view is pure theory and utterly unable of accomplishment; but of this the citizen will not be convinced, and each time an opening is made the company making it and the municipal authorities are unsparingly condemned.

The above may be described as the *theory* of street openings in a small town. The *practice* of street openings in a city, and especially a large one, is a very different matter. There are now so many public service corporations laying underground structures that openings, both for extensions and repairs, are of daily occurrence. In this continual disturbance of sub-surface conditions the gas company is at a disadvantage as compared with any other company. The water company, steam company and pneumatic tube company have about the same comparatively defenceless distributing system, but an ordinary leak of water or steam does no harm and an air leak will be quickly known. A gas leak, however, may, long before discovery, make an explosive mixture in conduits and manholes. The "electric" companies—viz., traction, light, telephone and telegraph—have a distributing system not easily damaged, and which gives the central station instant warning when serious damage occurs. So, of all underground service companies, the gas company has most need to watch its structures. What is more, this need and the expense entailed by meeting it, began sooner for the gas company. It was, except for the water company, the first on (under) the ground. In the last 15 years one by one the electric companies have put their wires in conduits, until each street intersection is undermined by manholes and from curb to curb the roadbed is filled with iron pipes and wooden and tile ducts.

What has been the effect of all this work upon the conditions of the gas mains and services? It is extremely probable that, except in a few of our largest cities, most of the conduits have been laid without any regular surveillance from the gas company. This means that wherever a main was uncovered in the side of a conduit trench, the tile, or their concrete bed, was very close to or touching the main, making service tapping or split sleeve repairs difficult and often impossible. Also, where the presence of a main in a manhole did not interfere with cable drawing or splicing, the manhole has inclosed the main without permission being asked. At once that inclosed portion becomes inaccessible to the gas company, according to manhole ethics as laid down by the electric companies, until permission to open the manhole has been asked and obtained. Little as any particular gas company might be inclined to ask this permission, especially when hunting for bad leaks, the asking becomes no formality when manhole covers are locked, or where, if not locked, the current carried is of high voltage, and prudence demands the presence of an employee of the electric company.

Consequently, the gas company which has not closely watched the installation of conduits, realizes one day that many of its mains and services are more or less imbedded in and under ducts, and that in manholes and manhole walls are mains and specials. The possibilities in manholes from leaky joints or broken mains are not pleasant to contemplate, and cast iron mains, especially in small sizes, may not be strained with impunity. If a 2-inch main affords an easy way of getting in or out of a manhole, it is a very possible occurrence that an extra heavy man may some day cause a slight crack. The first knowledge of an unholy union between gas and electricity may and often does come from a series of manhole explosions, in which broken covers and shattered ducts may cover the whole damage.

Whether because of such accidents or from any other reason let it be assumed that the manager has decided that both prudence and economy dictate a new policy in regard to watching the distribution system. There are two things to be done: First—To make sure that in the future any opening, uncovering or coming close to main or service will be seen, and proposed or actual encroachment or damage to the gas structure prevented or reported for the manager's action. Second—To investigate all existing dangerous conditions, which practically means, examine all manholes which probably inclose mains.

To accomplish the first object, a systematic inspection or "linewalking" of the whole system of mains must be started. Important thoroughfares and those containing the largest mains must be visited oftener than the streets in which there are apt to be few openings and on which the mains are small. By intelligent planning, very effective protection can be obtained at comparatively slight cost, say $8 per mile of main per year. Bicycles should be used by the "linewalkers," except possibly in the congested traffic centers. A report should be made of every opening seen. Where a trench is being opened parallel to a main, and the latter is exposed, it will often be advisable to detail a man as watcher on this particular job to insure that the structure being laid is kept at a proper distance from the main. An endeavor should always be made to agree with the other public service companies upon the minimum clearance distance allowable from different sized mains. These companies will usually be reasonable on such points and issue proper orders to the street gangs, but, of course, where space in a street is very limited, the ordinary street foreman will break rules made for another company's benefit, where these rules interfere with an economical or proper installation of his structure. It is to prevent the yielding to temptation by such foreman that the linewalker and the watcher are needed, fully as much as to look after the individual plumber.

Public service companies usually notify each other of the time and place of contemplated work, and a linewalker may be given such notice and ordered to report whether the work is such as to call for a watcher. Here again, however, the human element comes in, and quite frequently a notice is not sent or delayed until after the work is begun, so that the linewalker sees the opening before the office knows of it. A telephone conduit was once laid on Sunday, and notice to the gas company was forgotten. There being no linewalking on Sunday the work was never seen, and, therefore, there was no opportunity to object to the resting of a conduit on a service, causing the latter to sag 1 inch and to pull out of the main a few months later. The resulting escape of gas filled the conduit, and when the mixture was ignited by a plumber's furnace, several hundred dollars' damage was done to the conduit and to neighing windows. If notice had been sent, a watcher would have been on the job, and the damage, as well as resulting counter claims between the two companies, would have been avoided.

The encroachment peril is not in itself as dangerous to a main system as the peril from subsidence and breaking, due to deep excavations either close to or including a main. This comparative harmlessness of encroachment is no valid excuse for failure to protect the main system from it. The ordinary danger from excavation is due to sewer work, and either the linewalker or the watcher must see that the main is protected as well as possible from any chance of subsidence, either during the work or after its completion. If the main is outside the sheeting and the latter is to remain in, there is little to be done and not much trouble is apt to result. If the main is in the excavation, or just outside, and sheeting will be pulled, then supports from the sewer crown or spring of arch should be put, two under each length, and this, coupled with the custom of never allowing pipe smaller than 4-inch to remain in use under such conditions, will generally prevent any trouble from broken mains after the excavation is refilled.

A peculiarly modern peril to a main system is that due to the construction of a street car subway. Ordinarily such a subway is built by opening the street from above and excavating nearly to full depth in the open cut; then flooring is laid and the rest of the work proceeds under cover. Thus an immense chamber is formed under the street, inclosing gas and water mains, telephone and electric light conduits and any other structures that may have been in the street. Of course, any formation of an explosive mixture of gas and air is to be prevented by all means. The possibilities of such a mixture were disastrously shown in Boston several years ago.

If the gas main uncovered in the subway is a very large one, say over 12 inches, and especially if, by reason of a duplicate main, no services are supplied from the large main, the advisability of removing it from the excavation and laying a temporary pipe on or above the ground should be seriously considered. This practice was followed in New York city in at least one instance. If any main of whatever size is left under the flooring, then, besides a careful supervision of all supports as installed, a day-and-night patrol of the line should be maintained. Under each main should extend a platform so arranged that the linewalker walking on it will be in a position to smell any leaks. Also, vent holes should be made in the flooring, along the curb line and about 50 feet apart. Wooden chimneys, 2 feet square and 7 feet high, placed in these vent holes remove any menace to pedestrians and prevent cigar stumps, matches, etc., being dropped down.

Judging from experience, I think it safe to say that, in carrying out

any system of protection as here outlined for subway work, all expense, except the pay of the necessary line walkers, will be cheerfully met by the subway contractor, who is always keenly aware to the menace from gas mains.

The second phase of the work to be done in reducing the chances of serious street explosions from leaks in mains—viz., the investigation of existing dangerous conditions—is of necessity limited, as stated before, to an examination of all manholes which do or may contain mains. The manhole company will usually send a representative to accompany the employees of the gas company on these trips of examination. Wherever a main is found, a sketch should be made of the conditions. The extent to which the removal of mains should be carried will depend upon many things, not the least important being whether the manhole company will pay all or any part of the expense. There will be many locations where an avoidance of all present manholes is an impossibility, and also many where a circuitous route would avoid present manholes, but not the new ones sure to be built in the near future.

The plan followed for a main system embracing 1,300 miles and several thousand manholes has been to remove where feasible all mains, 6 inches and under in size, carrying them around the manhole. Where allowed to remain in the manhole, the pipe, if smaller than 6 inches, was increased to that size, all existing lead joints were replaced by cement, or removed by the relaying of the pipe, the brick work of the manhole walls was cut away from around the pipe for a clear space of about an inch, the space being filled with yarn and cement grout, the idea being to leave a water-tight wall, but to prevent any strain being transmitted to the pipe through the manhole wall.

The above programme has been carried through with comparatively little opposition from the manhole companies, and the proportion of the expense collected from them is satisfactory, considering previous local conditions. As a result of the linewalking system and manhole work, 8 years have elapsed without any serious manhole explosions due to gas, and the ones that have occurred have generally been the unmistakable result of unnecessary interference with the gas mains by one of the manhole companies, an interference which was protested against at the time, but which could not be entirely prevented.

[Prepared for the JOURNAL.]

Gas Traps.

By "ARTISAN."

Afthough calculated essentially for purposes of transporting water, there are often occasions upon which the ordinary gas trap is used in connection with gas pipes, which trap is intended to retain a collection of water to act as a barrier to the passage of foul gases in systems of drainage. The arrangement of turns in the pipe forming the trap is such that there is practically no interference with the traffic of the water or sewerage along the line, and the principle is applicable when gas flows though the pipes. The trap prevents the entrance of foreign gases, air, etc.

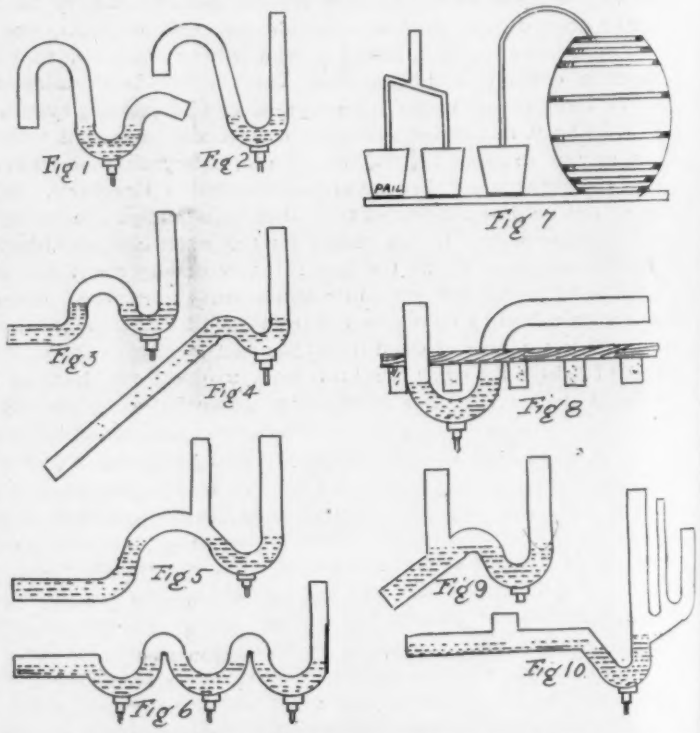
In the designing of gas traps for either service it is important that a perfect seal be obtained, for if there is a leakage at any point the value of the trap is lost, in that it becomes merely a conductor of whatever may be carried within the piping system. Gases, air and perhaps liquids may ooze in from the exterior, or perhaps the inferiority of the piping system may be such that the content of the pipes sweats through, resulting in odors and various complications. I have seen gas pipes packed in cement cases to overcome some little defect of this nature, which defect gives rise to leakages and odors. Again, we find pipes and connections liberally bound up in rags and all sorts of materials to avoid leakages of gases.

In the construction of the traps, care is taken not to develop a siphonable effect. There are, of course, both siphonable and non-siphonable traps in use, and each type has its place.

There are positions in which the siphonable trap is needed. This description of trap is shown in Fig. 1. The arrangement of the curve is such that a pocket is formed. The pocket fills with water to the water line shown in the shaded portion, thereby forming a seal for the passage. This water barrier makes a very simple obstruction for the passage. In order to shape a way for cleaning out the trap, a metal screw-cap is underneath the dip. The operation of cleaning is effected by removing the plug and permitting the accumulated matter to run out. Then water runs through the pipes and the trap is cleansed. Some various forms of the same designs of traps are presented in the illustrations extending from Figs. 2 to 6. The different inclines which are required to meet the conditions of the pipes in a building are arranged as required, so that in some cases the end of the pipe dips to a decided angle, as in Fig. 4. Then, again, the adjustment is such that the pipe extends straight out to the connection; or there may be cases in which series of traps are needed, as in Fig. 6. Here we find three separate traps, all arranged on the same plan and alike in size and detail, and although usually one trap suffices, sometimes two are needed to perform the work; in fact sometimes three are found to be more useful, as in this instance.

In Fig. 7 is shown an explanation of the plan of siphonage as applied to practical use in lines of pipes fitted with traps. A barrel of water may be set up as shown in the view. This barrel is filled with water to within about 20 inches of the top. Then a pail is placed near the barrel and the bent pipe adjusted as shown.

The lower end of the pipe is placed in the pail, the other end being placed in the barrel. In order to get the suction going one will have to remove the air in the pipe, which is readily done by placing the pipe in the mouth, one end being closed, and drawing the air out by suction. Close the end you are drawing through as soon as you remove the pipe from the mouth and dip the end into the water. The vacuum thus created will start the thing going. The atmospheric pressure upon the surface of the water in the barrel causes the water to enter the void in the pipe and the water flows readily to the pail. The flow is maintained until the water in the barrel goes to the level of the inlet end of the



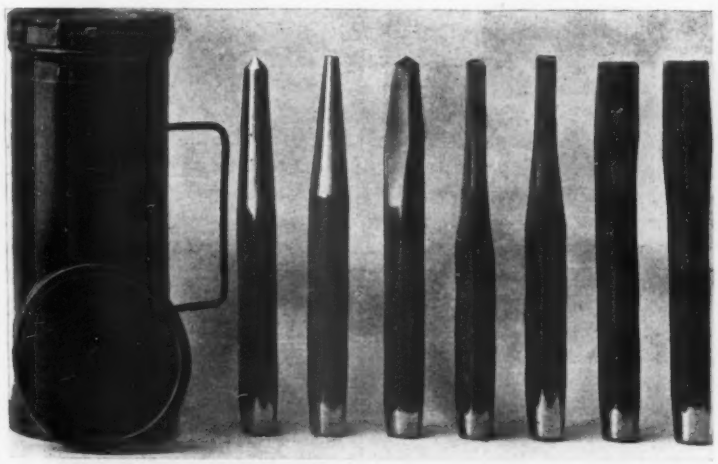
pipe. Then it stops. Here is where we get failures in the installation of air and gas traps in buildings. Sometimes the trap is perfectly made and seems ready for adjustment, but conditions arise in the placing of the trap in position that throw out the well-conceived plan. A new diagram has to be modelled before the adjustment is corrected. In one example, two pails were placed, as in the same cut, with a pipe bent to the order exhibited. One pail was filled and the other was empty. The experimenter sought to develop a vacuum by utilizing the central upright, which pipe lead direct into the angle. Ss long as he kept this top choked off and closed. and the water remained higher in one pail than in the other, the pipe siphoned the water into the pail containing the least water. The addition section was of no value. There is a great similarity between these two experiments and the actual gas and water trap. In actual service the vacuum is formed by the discharge of a fixture on a higher floor. Apparatus may be installed in houses, shops, offices, etc., which may act as a medium. Of course many primary factors interfere with the flow. I have seen cases in which hair, lint, pieces of fabric, toothpicks, thread, etc., found their way into the traps by the pipe passages, and these served to clog different operating mechanisms of the traps. The result is that the traps are often rendered useless for the time being. A thorough cleaning out will remedy the trouble. In Fig. 8 is shown a plan adopted in one case for the establishment of a trap below the floor line in a cupboard.

In the event of the clogging of the trap, difficulty is experienced in cleaning it out.

Capillary action on trap seals is another bothersome element. It is not liable to be seen readily, due to the difficulty experienced in getting at the right point, hence there is much tinkering at the more convenient points oftentimes before the affected part is reached. This is particularly the case in traps of the design exhibited in Figs. 9 and 10. These two latter styles are of special pattern, designed to meet the requirements of a certain mill service. Regardless of the character of the traps, if a reasonable amount of care and energy is given to them, reliance may be placed in them. Evaporation may bother at times; but a current of gas or air passing steadily over the water in the trap tends to evaporate the water in time. The time depends upon whether the trap is vented or unvented. If the latter, the trap remains sealed much longer. Back pressure is another factor, and it is usually due to a pressure of air from within the piping system, often due to defective alignment of the pipes.

The Mueller Handy Tool Kit.

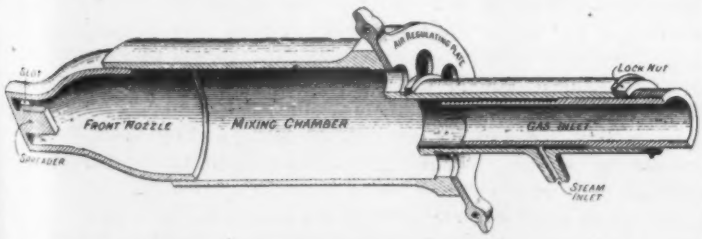
The H. Mueller Manufacturing Company, of Decatur, Ills., is finding ready sale for its "Handy Tool Kit," the plan of which is plainly shown in the illustration herewith. This kit, which is designed to be



especially convenient for the gasfitter, plumber and water works' man, consists of a center punch, round punch, diamond point chisel, cope chisel, cold chisel and calking chisel of the combination variety, arranged in a compartment box, lined with sole leather at top and bottom to prevent injury to the tools or box. The box has a strong swiveled handle, and the top of the box can be removed by a half turn; the result is that there can be no loosening or giving way. All the tools shown are made of high grade, ⅞ octagon steel, tempered and hardened at measured temperatures, thus insuring absolute uniformity of temper. To be positive that these tools are all that they should be, they are given at the factory a severe practical test. The box and its tool equipment have the unconditional guarantee of the Mueller Company.

The Branch Natural Gas Burner.

For burning natural gas under horizontal tubular and water tube boilers the National Equipment Company, St. Louis, Mo., is putting out the Branch natural gas burner herewith illustrated. The gas is



admitted to the burner through a 2-inch inlet pipe and passes into a mixing chamber where the necessary amount of air and steam mingles with the gas before it is discharged through the front nozzle. This nozzle has slots so that the flame produced is of a fan shape and spreads out under the boiler. Several advantages are claimed for the burner, principal among them being that it is easy to regulate accurately the ratio of the air and steam to the gas so as to produce perfect combustion and a uniform flame near the front end of the boiler. The jacket of steam which is provided around the gas intake pipe serves as a preheater for the gas before it enters the mixing chamber and promotes the combustion.

The construction of the burner is such that gas under any pressure may be used, it being only necessary to change the front nozzle, which is threaded to the mixing chamber of the burner, and different sized openings in this nozzle are supplied for different gas pressures. It is claimed that the burner may be forced to 100 per cent. overload when desired without any change. All parts of the burner are interchangeable.

Steel Nut Wrench No. 54.

Bemis & Call Hardware and Tool Company, Springfield, Mass., is putting on the market the steel nut wrench shown herewith. In its

construction special attention has been given to strength, durability and the quality of material used, and it is adapted for use where the wooden handle wrench will not answer. It is pointed out that water, steam or mud cannot injure it, and that the wrench is built on correct mechanical principles and is practically indestructible. The head, bar and shank are in one piece, steel forged. The handle is forced on to the wrench bar under great pressure, and then securely riveted in place. Being oval in form it fits and does not tire the hand. The nut gives great gripping power to the jaws, as on nuts with the corners rounded off the whole hand can be applied to making the adjustment. Ordinary adjustment can be made with the thumb and finger. It is made in 7 sizes, from 6 to 18-inch, inclusive, with steel handle, as shown in the cut. The 21 and 24-inch wrenches have a handle made by a continuation of the bar.

The Pressure of Light.

[By Mr. Thomas W. Kingsmill, of Shanghai, China, in *Engineering*.]

In *Engineering* of May 18 last appeared a notice of a paper by Prof. J. H. Poynting on "Some Astronomical Consequences of the Pressure of Light." I am not going to contravene the facts nor the conclusions arrived at. But does the argument begin and end with light rays? I trow not. A very few years ago the only rays that we knew to be transmitted by means of ethereal vibrations were those of light and heat. Now we know that they are manifold; Hertzian, Röntgen, Becquerel, and we know not how many more; α rays, β rays, etc., of many of which we make daily use. In fact, it may be said that ethereal radiation has become the quest of the century. Each of these—and they may be infinite—must mathematically be subject to the same laws; and the logical conclusion must therefore be, that it is insufficient in explaining any one celestial phenomenon to take into consideration one only out of the numerous classes of radiation with which we are already acquainted.

It is an old suggestion, made even in the eighteenth century, that gravity itself is but a form of radiation; but, of course, in the days when heat and light were the only known forms, such a theory could have no support from observed facts; and the known facts seemed to point directly to its being an attractive, not at all a repellent force. But modern discoveries tend to throw discredit on the existence of an attractive force, or rather, perhaps, afford no logical ground on which to erect such a force. On the other hand, all these forms of radiation point to the fact of the ether being in a state of everlasting vibration in every direction. This perpetual vibration is seemingly, indeed, the only fact that we know positively of the ether, all the other possible conceptions we can form of it being negative.

One of these conceptions must be that the ether cannot act on bodies direct, as otherwise we should find it a resisting medium to all motion; and this mathematical research shows as plainly it is not. Yet that its vibrations do affect every body in existence is plain from the ordinary phenomena of heat and light. There seems here only one escape from the apparent dilemma, and that is, that ethereal vibrations can communicate themselves to the ultimate particles or atoms, of which mat-

ter is necessarily built up. We then need to leave out of discussion momentarily all considerations of positive dimensions, and dismiss ideas of surface or figure, and confine ourselves rigidly to mass. This seems a defect in Professor Poynting's calculations. Assuming that perpetual vibration is one of the conditions of the ether, and that this vibration can communicate itself to the ultimate particles of matter, we seem to have some sort of a foundation for a vibratory theory of gravity, without calling in the aid of the unknown, and hardly thinkable, force of attraction. Experience, *e.g.*,teaches us that light passes equally at all times and in all directions, and as it is only through the vibrations of the ether that the passage of light can be effected, the vibrations must be ubiquitous in direction and uniform in time. In the case of a solitary atom, or congregation of atoms, the vibrations on every side and from every direction being equal and compensatory, there is no tendency to change of place; but when we take two atoms, or congregations of atoms, between the two must exist a penumbra whence certain of the rays will be excluded, and the tendency will be to approach. This seems to me to put the force of gravity on a logical basis. It will readily be seen from simple mathematics that the differences due to penumbra will follow the same rule as gravity. In the case of two bodies (or congregations of atoms) within measurable distances of one another, the undulations are in part then arrested by the atoms, which convert the undulation into topical motion tending to bring closer the bodies, while a part is consumed about the atom inducing on its part vibration.

Even with our present knowledge we may bring this to the test of what we may assume as experiment. Let us place in some corner of the ether, sufficiently removed from extraneous influences, two balls each containing, say, 100,000,000 atoms of, in the one case silver, in the other platinum, taking care not to give either any proper motion. We find that the two approach within the penumbra. The silver ball will contain, we shall find, 97 cubic units, the platinum 95, so that the diameters shall be very nearly equal. As each ball cantains 100,000,000 atoms, the moving force should seemingly be equal in each case, but we find they approach at very different rates, the silver ball passing through194.75 space units, while the platinum only accomplishes 101.85. As they are nearly of the same size, and each containing the same number of atoms, the silver ball must be less obstructed or permit more vibrations to pass through into the penumbra. The two balls being nearly of a size, and containing the same number of atoms, something must have been superadded or deducted from the vibrations in passing between or through the atoms; in other words, the conditions of pressure from without being identical, something must have occurred to make the back pressures in the penumbra unequal.

We may, perhaps, find the clue by trying a new experiment, and for that purpose place both balls, at a temperaiure of 200° C., in a mass of ice at 0° C., and ascertain the respective amount of ice turned into water during the time the balls were cooling to zero. Here we find a very similar discrepancy; the platinum ball will have melted 101.85 units, while the silver will have actually melted 186.66. That the coincidence is not accidental is shown by very similar effects occurring with other elements.

Let us, *e.g.*, for silver substitute magnesium—a metal of a very different category—and watch the results in both cases. The balls, as before, will approach, but at very different rates; while the platinum (as before) advances 101.85 units of space, the magnesium will have covered 816.47; owing, too, to the looser packing of the atoms, while the contents of the platinum ball are 95 cubic units, those of the magnesium are found to be 1,445, the diameter being as nearly as possible 2½ times as great. Now, as before, let us plunge the two in ice; we shall find that while (as before) the platinum will have melted 101.85 units, the magnesium will have liquefied no less than 796. As in the former case, the coincidence does not amount to identity, and as this discrepancy occurs in each case, differing slightly in amount, there must be some reason. Part is no doubt due to errors of observation, but it is too constant to be altogether due to that cause, and we must therefore seek for another explanation. Notable exceptions, due possibly to change of phase, only occur in four solid elementary bodies—carbon, boron, silicon and glucinum; while for similar reasons the law does not occur, or is masked in most of the permanent gases.

And now we can make a third experiment. We have seen that the platinum ball in falling in temperature 100° accomplished only the same (*quam. prox.*) amount of internal work amongst the atoms as did the magnesium in falling 12½°. If we now take the two balls and permit them to fall under the action of gravity, we can, by suitable means, ascertain the amount of work done topically, and we shall find it practically the converse. In other words, the platinum ball in descending gives out in 12½ space units as much energy, external, as does the other in falling 100. The actual energy transferred to each atom from the ethereal vibrations is identical, but the manner of application, as we may call it, differs. This seems to be the lesson to be learnt.

Of course, as we have not yet arrived at all the various forms of vibration to which the ether is subject, we have only dealt with two—heat and gravity; but, as I pointed out, all proceeding from the same source must follow similar laws. Now, Professor Poynting has shown how light rays falling on a body do actually bring pressure. In the same way we must look for similar phenomena from Hertzian, Röntgen, Becquerel, and all the numerous forms of vibration recently brought to our knowledge; and it is probably in this direction that we must look for the explanation of the discrepancies noticed in dealing only with the two chief radiations of gravity and heat.

Following the lead given by Professor Poynting, we may try to apply this simplified formula to some celestial movements. With regard, for instance, to comets, Professor Poynting, in accord with Euler, gives a formula requiring two distinct forces to account for the peculiarities of their orbital movements and their visible shape; one of these, the so-called attractive force of gravity, to produce the motion of the head, and the other, the repulsive force of light, to produce the phenomena of the tail. Palpably as indicated above, one is sufficient, when properly understood, to account for all the appearances. When, *e.g.*, the comet is first visible at or near its aphelion passage, it appears as a more or less globular congeries of particles, which from the necessities of the case we must assume to have a motion of rotation around their common center of gravity. However small the dimensions of the congeries, the momentarily foremost particles must be more strongly drawn towards the sun than the hindmost, and hence the resulting globe will from the first have a tendency to assume a spheroidal shape. As the congeries of rotating particles draws nearer to the sun in the progress to perihelion, the penesyzygial axis will continually become prolonged in quadratic ratio, and at the same time the center of gravity aud center of rotation will be drawn into the forward focus of the spheroid. As a body in revolution round the common center of gravity must cover equal sectors in equal times, the particles in front, in the pericentron, will be crowded together, and practically form a thick cloud, brightly glowing as it reflects the rays of the sun. The particles in the rear, becoming further apart as the distance from the center of gravity increases, will gradually be able to reflect less and less light, till the hindmost will altogether cease to be visible. Such is the ordinary aspect of a comet; and it will on consideration be seen that, in accordance with the laws of motion, such it must be.

So, too, in the case of a planet moving in an approximately circular orbit, the perihelion (pericentric) strains are so slight as to be practically inappreciable; and giant bodies like Jupiter get round their perihelion with no noticeable change of figure or condition. Not so those which, something like the comets, are condemned to move in orbits more or less eccentric. Let us for an instructive example take the hypothetical planet supposed to have once moved between Mars and Jupiter;i nstead of an agglomerated body we find it to consist at present of a lot of scattered fragments, scarcely one of which exceeds 100 miles in diameter, while most are mere points. Even Mars is insignificant in size, and his small diameter, coupled with his relatively low density, enables him almost without inconvenience to perform his regularly recurring perihelion plunge of 48 million miles.

The conclusion I must under the circumstances draw is that it is logically necessary to accept the vibrations of the ether, and their part in conveying radiations of all sorts and degrees, as the sole source of energy in our system, whatever form that energy assume—gravity, heat, light, electricity, etc. We can then comprehend how it is that gravity, so far from being a separate entity, with its own laws apart from the others, must be accepted into their society as but one of the practically innumerable forms of radiative energy, all capable of mutual transformation and interaction, according to the momentary conditions. Furthermore, we must assume that the atom, and the atom alone, can become the medium, and that bodies can only be affected inasmuch as they are built up of atoms.

The whole energy of vibration is not then concentrated in gravity, and as we can imagine what is called latent heat, so also is latent gravity a conceivable factor. We can, by suitable treatment, make latent heat sensible, and by a somewhat similar process we can also utilize latent gravity. In neither case are the vibrations at rest. In the case of conjoined bodies the entire mass now acts as a whole, yet even here the vibrations partake of a compound character, part tending to produce movement in space and a part engaged in internal oscillation. The former becomes adhesion, the latter heat, light, electricity,

etc. The interior of bodies is thus subjected to the same principles as their externals, and the principle of the impenetrability of matter is not to be held to extend to the ether. Here probably, too, we reach the finality of possible human knowledge.

Difficulties in Converting Gasoline Engines to Operate on Producer Gas.

[By J. E. PFEFFER, E.E., in *The Gas Engine.*]

Phases of work that cover any particular portion of the modern prime mover involving changes that are essential to the correct working of a producer gas outfit, as compared with ordinary gasoline or natural gas working, are, of course, always interesting. Creditable tests and performances have been made in the past few years with suction gas producer outfits, with various fuels, under absolute and unfavorable conditions for comparative purposes with other forms of power that have had to dwindle in importance in every case where efficiency and consistency of operation were prime factors in the case.

To justifiably treat this most important subject, it will not be amiss to demand of the student that he bear in mind, with great prudence, the fact that the factor of compression in explosive engines is of the utmost importance for deliberation for him who would reach the highest point of production with the full mixture he has at hand in connection with the energy producing conditions that are shaped into finality, and, as such, are ever a basis of contention that must not be overlooked in bringing about ideal power plant conditions for general and specific utilization.

Producer gas, as must be remembered, is a mixture of several elementary and compound gases, and is evolved in an apparatus in which the heat for the gasification of the combustible agent at hand is derived by a partial combustion of the raw fuel in the producer chamber, where the gas forming elements are first brought together in their raw and separate states to be combined, both in a mechanical and a chemical combination sense, to eventually be carried over and treated for its final inception by the engine cylinders for the compression of said compound gas to its most advantageous stage for final utilization, ignited, and, as heat energy, transformed to mechanical turning effort of the main engine shaft, from which useful work is derived.

Because, as is so often the case, the quality of the gas delivered to the engine will vary with different types of gas producing apparatus and with different gas producing agents as fuel, and because the nature of the work or mechanical effort as finally transformed into by the engine, affects very materially (for the most efficient transformation) the amount of compression, it will no doubt be advisable at this point of the discussion to dwell upon the nature of the gas as leaving the "producer chamber" above referred to, so as to realize the conditions evolved for our compression chamber in the case of producer gas before we proceed to bring about the conditions in our mechanical design of the compression chamber of the engine that will facilitate the changing over of same from a highly efficient gas, such as illuminating or natural gas, to one less so, or *vice versa*.

The producer gas being one of much less heat value than the natural or gasoline gas, it naturally requires a much higher compression in order to arrive at that stage of compression where the heat values will be practically the same as that of gasoline gas. To show the reason for the low heat value of this gas, it will also be advisable, at this point, to show the combination as to how the gas is made before being ready for utilization in the cylinder. During the first 5 years of the gas producer experience, air alone was utilized in the gas producer over a bed of coal. In the later and almost universal practice, owing to the better efficiency and more consistent production, a jet of steam, in connection with another of water, is passed through and over a bed of live coal in the gas producer, which together form the elements that make up the final gas. In this operation the air and steam are sent through from the sides and bottom of the fuel. The oxygen of the air, on first striking the zone of the incandescent coal, combines with the carbon to form the carbon dioxide (CO_2), but this, on passing through the burning coal above, is reduced to carbon monoxide (CO), which escapes with the hydrogen and carbon monoxide, resulting from the action of the steam on the red hot coal, and on the nitrogen which came in with the air. The resulting compound gas consists, therefore, almost entirely of carbon monoxide, hydrogen and nitrogen. A large amount of nitrogen in the air makes the producer gas contain 50 per cent. or more of that inert gas, and consequently gives it a low heat value, as above referred to. This state of affairs calls for a high compression in the cylinder, in order to get the best working conditions of the gas, and insures consistency of explosion and the consequent reliability of working in connection with the proper ignition apparatus.

Changing over of an engine from gasoline or natural gas to producer gas, then, calls for a much smaller compression space in order that the maximum power of the low heat value of producer gas may be obtained. Even when this condition is brought about, the producer gas result in the same engine must be considered to be some 30 per cent. less in the maximum power available than with a gasoline or natural gas operation. There have been various methods brought forward by different designers to accomplish this change-over without in any way affecting the general design and construction of the engine proper. One of these is to have an adjustable compression chamber, by virtue of a changeable head in some way, either by large plugs or some removable part, the definite location of which being such as to allow the area of the compression space to be changed. This system, although very practicable in the smaller sizes of engines, becomes very cumbersome and inadvisable for the larger powers that are more generally used for gas engine units of this nature. The second method is that of loose plates on top of the piston that can be inserted or removed at will until the right compression space is obtained, and is one that has been very largely applied, but not with the best of success. The plates are necessarily rather thin, and the attachment to the piston. head is always such as to allow the carbon deposits to assemble Another drawback is that unless the engine is made with an unusually separable head, the attachment is rather hard to make, and, considering the fact that no definite rule of reduction or increase of compression space can be made for a certain gas—as has been touched on above—this method of compression space regulation is rather a tedious and impracticable arrangement. The third and most reliable, as well as the most sensitive and ready method, is that of a changeable connecting rod—that is, changing the distance between centers of piston pin and crank pin, or, in other words, changing the length of the connecting rod by some screw or slip joint method to meet the conditions necessary. This latter method has become widely used and seems to be highly satisfactory. One of the most successful of these is where the piston pin bearing and coupling of the forged rod proper is involved in a steel casting or forging independent of the rest of the rod, and made with a long, coarse threaded hole for the reception of the connecting rod body, which can be screwed in or out, and then locked into position by the clamp bolt, which is put on one side, clamping a saw slot in the threaded wall, by virtue of passing through plugs thereon, attached on opposite sides of said slot, for the inception of the locking bolt. This method enables an adjustment of a half turn of the connecting rod, and can be gotten at from the crank case by removing the connecting rod bearing cap from the crank pin without taking down any other part of the engine. This consequently becomes at once a practicable and sensitive method. One objection to this method, however, is the fact that if the engine is running on gasoline or natural gas with the piston at its outer limit, the piston head is quite a distance inside that required for producer gas, and consequently allows a portion of the finished wall of the cylinder to be exposed at all times. This will allow that portion of the cylinder walls to become corroded, and, owing to serious carbon deposits and the fact of extreme heat during ignition, will naturally put the cylinder wall into bad shape for use when the producer gas is used, and at which time the piston would necessarily come out further on the cylinder wall than with the low compression gas, as gasoline and natural gas, for instance. However, under ordinary conditions, where a certain engine is installed and run on one gas, it would, of course, obviate this objection.

As has been said, no definite figures can be suggested in changing over from one system to the other for the best compression, owing to the fact that the nature of the gas varies so much, even from the same fuel, with different producers; and, furthermore, the nature of the work to be performed must always be taken into consideration for the best compression to be used in connection therewith. The general run of gasoline engines in the market to-day are very poorly suited for a producer gas engine working on the suction principle (as most of the producers made in this country to-day do work). This is due to the fact that the stroke and bore are too nearly equal and do not give enough suction per revolution as compared with the working area of the cylinder.

Producer gas engines, in the majority of applications, are operated with close regulation of speed by the utilization of a governor operating directly on the incoming mixture on the throttle principle. This governing of the engine to a certain speed makes a much more consistent and reliable working unit in connection with the suction gas producer.

The water and the air injected in the producer can be arranged to operate regularly and with precision, so that no particular attention to the apparatus is required, and the working conditions are practically the same at all times. The desirable ratio of stroke to cylinder bore in the working of producer gas units, particularly so the larger units, as experienced by the writer, is about 2 to 1, or nearly so. One of the best units the writer has had the pleasure of installing and operating under the most trying conditions was one in which the cylinders were of 10-inch bore and 18-inch stroke. This was a 4-cylinder unit and gave an actual B.H.P. of 110, consistently, at 275 r.p.m. This ratio of bore and stroke allows a unit to be operated under a slow rotative speed, which is always desirable in this connection, and yet obtain a comparatively high piston speed, so as to get a consistent and strong suction at the producer, as is very often not the case with the shorter stroke engines working at the proportionately higher rotative speed. This latter naturally involves a rapid intermittent acting suction, as compared with the longer stroke under same piston speed conditions. Another desirable condition that has obtained with the longer stroke is the low pressure at release and a consequent low mean effective pressure for the work stroke. In the writer's experience with these pressures it might be well to state here that under ordinary conditions the mean effective pressure should be in the neighborhood of 60 pounds and a release pressure of approximately one-half that. The maximum pressure, with ordinary fuel conditions and producer gas, will be 260 to 310. The governing of producer gas engines will, in most cases, be found to be preferable when accomplished as stated above, but in many cases the hit-and-miss principle, in connection with a governor, is still utilized.

This latter system of governing is generally objectionable, owing to the disruptive effort due to irregularity in explosions and consequently particularly objectionable to units requiring close regulation and smooth, uniform operation. The objection to the throttling method is inefficiency on the light loads, due to back pressures on the suction stroke; but, all in all, it is the better method, in the writer's opinion.

The ignition apparatus which has been found most practicable and which works most consistently in producer gas engines, more so than in any other class of explosive engines, is the hammer and brake electric system, with an extra igniter outfit for each cylinder. However, a high tension spark plug system can be utilized for the smaller engines where an approximate cylinder bore of 6 inches is utilized. The hammer and brake system is advantageous from the fact that a better location for the ignition in the compressed chamber can be gotten, and also a longer spark can be made, a condition particularly preferable with slow speed, large displacement engines.

In conclusion, to the change over necessary for gasoline or natural gas engines, we have, then, principally, to look out for two things, viz., the compression space and the speed governing, as a producer gas engine will not work at high efficiency and with great consistency under highly variable loads and at great variations of speed, as has been pointed out above. (This does in no way refer to where changes of load are gradual.) This fact is principally due to the fuel bed in the producer, which should be kept constant for any load, and the constant feeding in of the fuel to the hopper above. If, for instance, the producer outfit should run under a certain load and then this load be suddenly decreased to a much lighter load, with the inevitable necessity of raising the load again suddenly, the sudden increase of load upon the engine would increase the call for fuel suddenly, owing to the greater volume of gasoline taken by the engine and the required volume generated from the less coal (a condition to which the producer is adjusted to under the light loads).

There are manufacturers at present, especially in countries abroad, who furnish their power equipments to run on either gasoline or producer gas, as well as other distillates; but, of course, in most cases a customer definitely decides what he wishes the outfit to run under or to operate on as to the matter of fuel, and consequently the outfit can be definitely adjusted and equipped before leaving the factory. There are also numerous producer gas outfits operating to-day, but of rather small power, which have been changed over from gasoline outfits by simply changing the compression to suit and exercising the necessary precautions in governing the ignition. These outfits, the writer has found, in most cases to operate successfully, althongh, in general, at a much lower efficiency than could be obtained by securing similar sized outfits directly from the factory to suit the conditions involved.

As a further matter of conclusion on the successful operation of a producer gas outfit, much depends upon the care and management exercised by the man in charge. The extremely successful operation depends largely on the intelligent care and accurate adjustment of the various parts in combination to suit the conditions exactly, brought about by a clear understanding of the process going on from the producer to the cylinder during performance of the particular work at hand. It sometimes happens that the engine fails to start, although the ordinary starting operations have been carried out faithfully. Most common causes of this difficulty are incorrect strength of mixture, failure of proper ignition and leakages of the charge somewhere along the circuit. The setting of the gas valves, as well as the air and water injections, which give a satisfactory mixture one day may give a non-explosive mixture the following day, as a result of variation of pressures of the gas, or other charge, due to the various causes above enumerated, the principal one of which will be leakage of some one point. In case of failure to start, the strength of the mixture should be varied, and if this is ineffective, the ignition system should be tried out. The batteries, or other sources of current, may have weakened as a result of much use or of short circuiting, and should be tested out by short circuiting momentarily, at which time there should be produced a bright spark. Excess strength of the current is always objectionable, as it burns the contact points rapidly. In this connection it is well to have on hand a spare set of cells for putting in a circuit in case of an insufficient strength of current being detected at any time. There should always be a switch in the battery or other current circuit, which should always be thrown out when the engine is shut down, so as to absolutely prevent short circuiting. The trouble with the electrodes, as is often the case, is due to their having become foul or wet, or, as is the case in the make and brake system, by a gumming of the spindle of the moving electrode, making it sticky and slow in action. If the trouble is not with the igniter, it may be caused by the leakage of the charge. To test this, if the engine is not too large, it is pulled over by hand. The resistance, as turning on the compression stroke, should be very considerable. If this is not the case, the compression charge is escaping—providing, of course, that the compression space in the cylinder is correct in the case of producer gas engines. The normal compression will be at least over 100 pounds to the square inch, a pressure which should be very noticeable on turning the engine over the compression stroke, as compared with the clearing stroke, when no compression of any kind is possible. The leakage mentioned may be either past the piston, the ignition apparatus or the valves. If the leakage is past the piston, it is either due to the wearing of the cylinders or to the sticking of the piston rings.

The latter is very liable to occur after continued usage of a producer gas engine, and can be remedied by taking out the piston and loosening the rings with kerosene. The leakage past the valves is either due to gumming of the valves or to other deposits which keeps the valve off of its true seat and causes non-uniform wear of the valve seat or striking of the valve stem in its guide as the result of imperfect lubrication of the guides. The gumming and wear of the exhaust valve is the most common cause of leakage, and may be remedied as in any gas engine valve, viz., by grinding the valves with flour of emery and oil on its seat.

In the larger unit, trouble is sometimes experienced from the presence of water in the cylinder which has leaked in from the immense jackets surrounding the cylinders through imperfect joints and undue pressure; causing the electrodes of the ignition apparatus to become wet and preventing the engine from starting. This difficulty is overcome, in some of the more recent types of producer gas engines, by constructing them so that there are no packing joints in the cylinder—that is, the cylinder head is cast integral with the cylinder proper; and the exhaust in these cases is usually carried out through the exhaust valve, placed directly on top of the engine, central with the cylinder, a method which has given very satisfactory results, and in most cases, for the larger types of engines, given better efficiency than was possible with the exhaust valves on the side of the compression chamber.

Parties changing over their power plants from steam to gas engines must also remember that cylinder oil used in the steam engines cannot be used in gas engines, as it carbonizes at the high temperatures of the explosions, and forms a carbon deposit in the cylinder and on the exhaust valve. For gas engine purposes, a lighter oil is necessary, and is always used with good results; althought even then, if supplied in too large quantities, it causes a gradual accumulation of hard deposits in the cylinder which must be cleaned out occasionally. However, the operator will learn, after some experience, to know just how much lubrication is necessary and just where to set his lubricators to get the best results. Too much lubrication is also detrimental in another way, besides interfering with the action of the igniter and valves, due to the carbon deposits—that is, it is liable to cause premature ignition by being raised to incandescence.

The necessity of good cooling in the larger explosive engines is very important, and cold water must be kept circulating through the jackets

whenever the engine is running, being started as soon as the cylinders warm up. Failure to do this, even for a comparatively short time, is liable to have a disastrous effect upon the cylinders, although a similar experience on a small-sized engine would have no bad results whatever. A gradual accumulation of sediment is liable to occur in the water jackets, with a consequent reduction in its efficiency. On shutting down a large explosive unit, it is always better to drain the jacket at the bottom, which not only prevents possibility of its freezing up in winter, but also tends to clear out all sediment, and avoiding the consequent danger of overheating due to defective circulation of the cooling water.

Protective Coatings for Steel.

[From a paper by MR. ARTHUR B. HARRISON, read at the Atlantic City meeting of the American Society for Testing Materials, June 21, 1906.]

Protective coatings should be divided into three classes: 1. Linseed oil paints. 2. Varnish and enamel paints. 3. Carbon coatings, using solvents that dry by evaporation. The all-important factor in protective coatings for the preservation of steel is their efficiency under conditions of exposure as they are, and not as they should be or as we would like to have them. A vast amount of valuable information has been given as to how steel should be prepared for coating. We may as well face the conditions as they are in practice, knowing as we do that steel is seldom properly prepared for coating and never will be. Mill scale, rust, dampness and even dirt are more frequently covered up than removed before the coating is applied.

For many years this question has occupied the minds of leading engineers, and yet up to the present time it has resulted in little but theorizing and temporizing, and no definite conclusions have been arrived at except that all coatings seem to fail in time. It seems to be the general opinion that there are no coatings that will protect steel against corrosion under all conditions, and yet sooner or later the coating that will serve the purpose best under normal conditions will be recognized as the standard coating for this particular branch of work.

Linseed Oil and Carbon Coatings.—It was stated by the late Edward Atkinson, of Boston, some years ago that any coating that contained linseed oil and dried by oxidation tended to corrode steel. It seems to me that this should be absolutely determined, and if after experiments, tests and chemical analysis it proves to be the fact, it should be so stated, in order that engineers can turn to other channels, and by the most thorough investigation in the laboratory and in the field, and under all possible conditions, find a material that when applied to steel will protect it better than any other. If it is true that linseed oil or a coating that contains linseed oil as a vehicle lacks the efficiency and permanency claimed for it, that fact should be determined and announced.

In the past certain weaknesses have been assisted and have developed in connection with the use of carbon coatings; but if results were placed in parallel columns there is no doubt that the efficiency of carbon coatings would be found to exceed by far that of paints containing linseed oil as a vehicle for a protective coating. I know that there are certain inherent weaknesses in carbon coatings due to the following reasons: There is a tendency in such coatings not to oxidize, for the simple reason that generally there is nothing in the material to oxidize. One point advanced by some authorities, who seem to give great weight to it and consider it a weakness, is that the carbon coating fades and becomes gray, due to the action of the sun. But there is one fact they forget, and that is that the manufacturers of carbon coating do not claim that the material is a paint. These carbon mixtures are not put upon the market to serve the purpose of a paint, but as a coating to protect steel. In the one case we have a paint used for color and in the other simply a protective agent, and I believe that in future we should make this distinction. An oil paint upon wood serves first as a colored surface and second as a protective medium and its failure in either direction would indicate its inefficiency. A coating upon steel, on the other hand, should be simply and solely a protective coating, and the permanency of its color is a trivial and insignificant matter.

We need no microscopic slides on a screen to prove to us that steel rusts. What the engineering world desires to know is this: Steel being received in a rusty condition, what is the best material to apply to it in its normal condition to arrest and prevent further rust? It appears to me that it is only a question of a comparatively short time before this problem will assume a far more satisfactory phase, as I believe its solution has been hampered to a great extent by depending upon chemical reactions and mechanical mixtures. It is my opinion, further, that we will go back to nature—that we will be obliged to depend upon a natural product.

Paint Compounds.—Many scientific, technical and practical data have been given as to pigments, oil, etc., how pigments should be pulverized to a fineness known as air-floated, ground in pure linseed oil, etc., whereas in practice we find that of the pigments used in paints a great proportion would not go through a 60-mesh sieve, much less being air-floated. Result, inefficiency. There is no such commodity on the market as pure linseed oil. Other seed-bearing plants grow along with the flax and all the seeds are gathered and pressed together. This, however, is not the only adulteration to which linseed oil is subject. Let us take, for instance, red lead, which has been largely used as a preservative coating for steel. In order to obtain the best results and the full efficiency of this pigment it should be thoroughly mixed with linseed oil and kept well stirred while being applied, small quantities only being mixed at one time. This, we know, is seldom done. I have seen some specifications from engineers calling for one helper to stir the red lead for every two brushmen. Other specifications call for the pot of red lead to be stirred between brushfuls when being applied by the painter. This we also know is seldom done.

The same applies to any paint in which the pigment is much heavier than the vehicle, the efficiency being lessened or lost in the application in which the poor quality and kind of brush used is an important factor, wall brushes and cheap paint brushes being too prevalent. In mixing paints I think too little attention is given by the manufacturer to compounding pigments. A pigment may be absolutely inert in itself, but when brought in combination with other pigments chemical or galvanic action may begin and the so-called protective paint becomes a destructive agent when applied to the metal.

Experiments in New Lines.—At our mill on the water front in Brooklyn, located in the heart of the chemical district, where the atmospheric conditions are probably the most severe of any part of New York, we add our quota to the numerous destructive gases from a battery of calcining kettles; in fact, a large portion of the mill is constantly enveloped in vapor heavily charged with sulphuric acid gas from our kettles. The result on corrugated steel roof sheathing, and in fact any other steel, was simply appalling, as the steel was eaten away in a very short time. We were unable to buy a paint that would protect this metal under prevailing conditions, even for a few months. As it was a case of self-preservation and protection, I started a series of investigations and tests to procure a coating that would protect. As man and science seemed to have failed I went back to nature and procured samples of bitumen, hydrocarbon and asphaltum from all over the world. After hard work, both practical and technical, and scores of tests covering a period of years in laboratory and in field, I selected one of these products, which seemed to have the necessary qualifications to protect steel against corrosion under the most severe conditions.

This material is found in the West and resembles in composition and in many of its characteristics the mineral ozokenite. It is unique among deposits of mineral wax in its adaptability to the formation of a tough, impervious and extremely adhesive coating, with a high degree of elasticity. It lacks the brittleness of many of these deposits and is distinguished from all other deposits of what is commonly known as asphalt by the qualifications just enumerated. By a special process of refining the material can be prepared for the market with a very small percentage of residuum, grit and rock, and at the same time valuable characteristics are preserved.

It is my belief that no coating will protect steel against corrosion which is not absolutely waterproof, in addition to which it should have the following properties: The bond between the metal and the coating should be perfect. It should remain elastic under all conditions of temperature and after having been applied for years. It should be impervious to acids and alkalies and should resist the action of all gases. The material should be absolutely inert and a non-conductor of electricity.

Some authorities state that corrosion of steel is due solely to electrolytic action. I believe that corrosion is greatly accelerated by the action of the electrolyte, which, as we know, consists of moisture in any form and must be acidulated or saline. We require a coating which will prevent this electrolyte or moisture from coming in contact with the steel. Many oil paints which contain oxide or carbon as a pigment are good conductors of electricity, and a paint having such a conductor among its ingredients is much less likely to protect against electrolytic action.

A Displacement of Moisture.—Moist air tends to impregnate and saturate an oil paint coating on steel more thoroughly than direct im-

mersion, and after the humidity has been dispelled the pigment in such a coating retains the moisture and holds it against the steel for many hours. Having finally dried out it leaves a more or less porous coating, exposing the metal to all the other oxidizing elements. I should like to give to this society the benefit of some of my experiments with this material on steel surfaces which were coated with rust to the thickness of from $\frac{1}{64}$ to $\frac{1}{16}$ inch. As you know, a large portion of this rust scale is moisture. Mr. Wood says: "Rust begets rust, and unless rust is removed from ferric bodies corrosion will continue, even though the surface be covered with a good paint." After coating the surface on which this rust scale was I allowed the coating to remain for 30 days and then removed the scale with a putty knife. Much to my surprise I found there was no moisture left in this scale. My test to ascertain this was made by dropping pieces of the scale into boiling wax, which was at a temperature of over 350° F. The absence of bubbles proved beyond all question that there was no moisture present. Had there been very many bubbles would have been seen.

Another experiment was to coat clean, wet, iron castings with this material, first rubbing off the surplus moisture with a rag and immediately thereafter applying the coating. An examination of these coatings months afterward proved that they were absolutely free from rust. Had the moisture remained on the surface of the iron corrosion must have been the result.

My theory is that this material has such a phenomenal bond and affinity with all ferric bodies that it displaces moisture, and the moisture being driven out comes to the surface with the solvent and evaporates. This same theory applies to the rust scale, as on examining pieces of this scale I found they were saturated through and through with the material, and where the scale was thin had been actually cemented to the surface of the steel.

In practical field tests on this same order one of the great corporations of the country coated some 20 pumps. These pumps were under the bed of a salt river and were used for keeping the tunnel clear of leakage. The pumps being kept constantly in action were much cooler than the atmosphere in the tunnel and condensation was therefore very great; the pumps were actually running with water all the time. The pumps were coated with this material, two men being required for the operation, one to rub the water off the pump with a rag, while the brush man followed him and supplied the coating. The coating set and became hard after an hour and remained on the pumps, protecting them against further corrosion since its application, about a year ago.

In addition, in field tests I have in mind a number of instances where the results have been equally satisfactory and gratifying both to myself and to the interested parties, in the work done in paper and pulp mills, where nothing has stood before; in tunnels, where the blast from the engine and gases were so destructive to all metals; in train sheds, roundhouses and overhead bridges. In none of this practical field work has the material fallen down.

I found many corporations and municipalities refused to use a true carbon coating, even though in efficiency it proved to be the best preservative coating. This was on account of its being black and the fact that they were unable to procure an oil paint of lighter shade that could be applied as a finish coat, on account of the color striking through.

A Carbon Coating Covered with Oil Paint.—After reading the statement made by the late Edward Atkinson I took up, first as a pastime and then as a serious proposition, the question of the oxidation of linseed oil, having made up my mind that the life of a paint depended upon the life of the oil. The results were very gratifying, because I ascertained by a long series of tests in the laboratory and in the field that I could take linseed oil and by treating it with certain processes could prolong the life of the oil—I will not say indefinitely—but the life of the linseed oil was prolonged and its efficiency increased to such an extent that paint made with it as a vehicle would resist the action of the strongest paint removers, gas drip, benzol, etc., and a paint made with this treated oil would go over a carbon coating perfectly without the color striking through. The co-efficients of expansion and contraction seem to be identical, so that we are now able to furnish nature's pure carbon coating as a preservative coating, on top of which an oil paint can be applied, acting as a decorative coating and at the same time protecting the carbon coating from the rays of the sun, which seem to be its only enemy in nature.

THE water gas addition to the plant of the Northampton (Mass.) Gas Company has been completed.

Simple Methods of Gas Analysis.

[Read by MR. S. J. B. TULLY, of Kinsale, at the last meeting of the Irish Association of Gas Managers.]

The object of this paper is not to expound any new theory or method of gas analysis, but to explain a simple and cheap apparatus, and to interest managers of small gas works in this most important subject. The writer—to avoid confusion, and to make the subject as simple as possible—is confining himself to only one class of apparatus and one absorbent in each case; and anyone having mastered the manipulation of this apparatus will have no difficulty whatever in using any other apparatus or absorbents. For further information on the subject, he recommends the study of "Technical Gas Analysis" by Winkler and Lunge.

Gas analysis is not an everyday occurrence in small works; but an apparatus such as is described should form part of the equipment of even the smallest gas works; as, by its use, producer gas and flue gas can be tested, and the greatest fuel economy obtained. With the same apparatus it is possible to make a complete analysis of illuminating or any other gases. The results obtained are not absolutely accurate, but are sufficiently so for practical working purposes. There are many forms of apparatus for this purpose; but the author is of opinion that the one described best meets the requirements of small gas works, where the apparatus would not be in very constant use.

The following is a list of apparatus and chemicals necessary to make a complete analysis of illuminating gas:

Apparatus.

1 Bunte gas burette, 110 c.c. capacity, and divided into fifths of a cubic centimeter, fitted with a patent cock.
1 burette stand, fitted with two clamps, for Bunte burette.
4 pinch-cocks, with mohair clips.
8 feet of ¼-inch rubber tube.
2 24-ounce stoppered bottles.
1 small glass cup.
2 aspirating bottles, 2 liter.
1 24-ounce water bottle.
½ pound ¼-inch glass tube.
2 feet of ¼-inch glass tube. $\frac{1}{16}$-inch bore.
3 ¼-inch glass stop cocks.
1 8-ounce wash bottle.
6 12-ounce stock bottles with glass stoppers.
3 beakers, Nos 1, 2 and 3.
1 Hempel's explosion pipette.
2 rubber corks, Nos. 2A 1 hole.
2 do., No. 3A 1 hole.
Induction coil and battery.

Chemicals.

1 ounce pyrogallic acid.
1 pound caustic potash.
½ pound copper chloride.
1 pound black manganese dioxide.
1 pound chromic acid.
1 ounce bromine.
½ pound copper turnings.
1 pound acetate of lead.
1 pound potassium chlorate.
1 pound nitric acid (pure).
8 ounces hydrochloric acid (pure).

Total cost of apparatus and chemicals, about $20.

PREPARATION OF ABSORBENT SOLUTIONS.

Having obtained the necessary apparatus, chemicals and stock bottles, the next step is to prepare the stock solutions for the absorption of the various constituents from the sample of gas under examination.

The following is a list of solutions required and the mode of preparation:

1. *Potassium Hydrate Solution.*—Dissolve ½ pound of stick potash in distilled water. Stick potash sold as "purified in alcohol" must not be used, as it will cause errors in the determination of the hydrocarbons in illuminating gas.

2. *Alkaline Pyrogallate Solution.*—Dissolve 10 grains of pyrogallic acid in 200 c.c. of potassium hydrate solution. This solution must be kept in a good stoppered bottle.

3. *Bromine Solution* is made by shaking a few drops of bromine with water until the water is saturated.

4. *Fuming Nitric Acid.*

5. *Cuprous Chloride* (*acid solution*) is prepared by dissolving 27 grains of cuprous chloride in 200 c.c. of hydrochloric acid of 1.124 specific gravity. The solution must be kept in a bottle with a well greased stopper, and two or three spirals of copper placed in the solution should reach the top of the bottle. When free from the products of oxidation this solution is clear and colorless.

6. *Oxygen* is best prepared in an iron retort made out of a piece of 1-inch gas pipe, about 6 inches long, with a cap on one end and a 1-inch by ¼-inch reducing socket and a short piece of 1-inch pipe at the other end. This retort is about ¼ filled with equal proportions of dry pulverized potassium chlorate and manganese dioxide. The end of the tube is then heated until the gas is evolved freely. This should be allowed to proceed for a few minutes, and then the gas collected in an aspirating bottle and kept ready for use.

APPLICATION OF ABSORBENT SOLUTIONS.

1. *Potassium hydrate solution* absorbs carbon dioxide, chlorine, hydrogen chloride, hydrogen sulphide, and sulphur dioxide.
2. *Alkaline pyrogallic solution* absorbs oxygen.
3. *Bromine solution* absorbs the olefine hydrocarbons.
4. *Fuming nitric acid* absorbs benzene vapors and the olefine hydrocarbons.
5. *Cuprous chloride solution* absorbs carbon monoxide, also carbon dioxide, oxygen and heavy hydrocarbons, which must first be removed from the gas before estimating for carbon monoxide.
6. *Oxygen* is used in the determination of hydrogen, methane, and carbon monoxide by explosion.

The preparation of the apparatus for use, and the method selected for collecting a sample of gas, will vary according to the conditions under which the gas has to be taken, conveyed and stored. If the gas is collected in a laboratory, it is generally passed direct into the Bunte burette. A sample of gas which has to be collected away from the laboratory may be taken and safely stored in an aspirating bottle. When the sample is to be withdrawn into the burette from gas issuing at pressure from a tap, it is sufficient to connect the tap with the nozzle of the burette by a short piece of flexible tubing, and allow the gas to stream through the burette for some few minutes. The stop cocks are turned so as to shut off the interior of the burette from external communication as soon as the burette is filled with gas. If the sample has to be taken from a flue or shaft, a piece of ½-inch iron gas piping, from 3 to 5 feet in length, is connected by flexible tubing to the barrel of the stop cock of the burette, or it can be collected in an aspirating bottle.

The burette has previously been filled with water, which is run out through the lower cock to admit the gas. When the sample is taken, the stem of the upper cock may be closed. The burette is supported in a cork lined screw clamp in a vertical position, and allowed to remain in a cistern of water for a few minutes for the gas within to attain the temperature of the water. The cup is then filled with water, the upper cock opened, and some of the water allowed to flow into the burette. If the gas was cold when admitted, only a few drops may enter, In any case there will be sufficient to fill the capillary tube below the lower cock, which is done by turning on the cock for a moment. A piece of rubber tubing of suitable diameter is connected to a water bottle fixed a few feet above the top of the burette. The flow of water is regulated by a spring clip on the tube a few inches from its free end. While the water is flowing from it, the end of the tube is pressed over the nozzle of the burette; the lower cock is then turned on, and the water is allowed to rise in the burette to the zero mark. The reading should be made with the cup filled exactly to one of the marks on it, and all subsequent readings should be made with the water at the same level in the cup.

The upper cock is turned off and a piece of flexible tubing, connected through a Woulfe bottle, is attached to the nozzle; the lower tap is turned, and the water in the burette is sucked out until the level stands only a few millimeters above the lower cock, which is then turned off. A small cup or a porcelain crucible is nearly filled with solution of caustic potash, and the nozzle is immersed in the solution. The lower cock is then turned on and the solution flows up into the burette. When it ceases to rise the lower cock is closed, and the burette is taken from the supporting clamp, and, while held by the nozzle and the cup, is shaken so as to bring the contained liquid intimately in contact with the gas. After agitation for a few minutes the burette is returned to the stand, the cup is filled with water and the upper cock is opened. Throughout the shifting and agitation of the burette care should be taken to avoid, as far as possible, the handling of the body of it, so that the warmth of the hand may not affect the volume of the gas.

With the proper head of water in the cup the level of the water in the burette is read off, and the diminution in the volume of the gas since the initial reading gives the percentage of carbonic acid in the gas. The temperature of the water should be observed at the time of each reading on a thermometer suspended near the burette. The upper stop cock is then shut and the liquid partially drawn from the burette, and some freshly made solution of pyrogallic acid introduced in the same manner as the solution of potash, and followed by more potash if necessary. Agitate as before, but for a rather longer time, and read with similar precautions. The absorption since the preceding reading represents the percentage of oxygen in the gas. The solution is entirely removed from the burette by alternate suction and admission of water from the lower cock. Bromine water is then passed up into the burette. Care must be taken that the bromine vapor does not cause a greater pressure than the atmospheric within the burette; but diluted solution of potash, should be run through the burette from the cup in order to remove bromine vapor before the reading is made. The diminution in volume of the gas since the preceding reading gives the percentage of hydrocarbons present. The fuming nitric acid and cuprous chloride solution are admitted in the same way as the bromine.

To estimate the hydrogen, methane and nitrogen, take about 30 c.c. of the above mixture, and make up to 75 c.c. by mixture with oxygen. The mixture is then run in a form of Hempel explosion pipette. The mixture is fired by the spark from an induction coil. The decrease in volume caused by the firing is noted; and further diminution of volume resulting from the absorption of the carbon dioxide produced is also noted. The volume of methane originally present in the mixture is equal to the volume of carbon dioxide absorbed, as is seen from the equation—$CH_4 + 2O_2 = CO_2 + 2H_2O$.

EXAMPLE OF COAL GAS ANALYSIS.

The sample of coal gas was collected in a Bunte burette containing water which had been previously saturated with coal gas by passing gas through it. The gas was treated successively with the following reagents, with the results stated:

(1) *Potassium Hydrate Solution.*

	c.c.
Before absorption	100
After absorption	98.6
Volume of CO_2	1.4

(2) *Alkaline Solution.*

	c.c.
Before absorption	98.6
After absorption	98.2
Volume of O	0.4

(3) *Bromide Solution followed by Potassium Hydrate Solution.*

	c.c.
Before absorption	98.2
After absorption	92.6
Volume of $C_{11}H_{10}$	5.6

(4) *Fuming Nitric Acid Solution followed by Potassium Hydrate Solution.*

	c.c.
Before absorption	92.6
After absorption	92.3
Volume of C_6H_6	0.3

(5) *Cuprous Chloride Solution followed by Potassium Hydrate Solution.*

Before absorption, 92.3 c.c.; after, 85.6 c.c.; volume of CO, 6.7 c.c.

The residual 85.6 c.c. of gas contains methane, hydrogen and nitrogen. Then 30.8 c.c. of the gas were mixed with sufficient oxygen in the burette; and the total volume was now 75.2. This mixture was fired with the spark of the induction coil, the volume read off, and the residual gas exposed to absorption by the potassium hydrate solution. The volume read was as follows:

	c.c.		c.c.
Before firing	75.2	Before absorption	25.9
After firing	25.9	After absorption	13.9
Total contraction	49.3	CO_2 from CH_4	12.0

Hence the volume of CH_4 = 12 c.c.

$$\text{Percentage of } CH_4 = 12 \times \frac{85.6}{30.8} = 33.35\ CH_4$$

$$\text{Volume of H} = \frac{2(49.3 - 2 \times 12)}{3} = \frac{2 \times 25\ 3}{3} = 16.9$$

$$\text{Percentage of H} = 16.9 \times \frac{85.6}{30.8} = 46.96$$

Difference nitrogen.

Analysis of Producer Gas (100 c.c. Taken).

1.6—1.6 H_2S, etc.	6.2— 0.8 O
5.4—3.8 CO_2	31.4—25 2 CO.

The residual 68.6 c.c. of gas contained methane, hydrogen and nitrogen. Then 33 c.c. of the gas were mixed with sufficient oxygen in the burette, so that the total volume was now 53.6 c.c.

	c.c.		c.c.
Before firing	53.6	Before absorption	43
After firing	43	After absorption	42
Total contraction	10.6	CO_2 from CH_4	1

$$\text{Percentage of } CH_4 = \frac{1 \times 68.6}{33} = 2.07$$

$$\text{Volume H} = \frac{2\ (10.6 - 2 \times 1)}{3} = \frac{2 \times 8.6}{3} = 5.73$$

$$\text{Percentage of hydrogen} = 5.73 \times \frac{68.6}{33} = 11.91$$

Difference nitrogen.

It is impossible in a paper such as this to deal at any great length with gas analysis; but it is hoped that this will help many in making a start in the study of this most important and deeply interesting subject.

Gas Engines for Ship Propulsion.

At the last meeting of the English Institution of Naval Architects, a paper on the named subject was read by Mr. J. E. Thornycroft, in which the author said:

At the spring meeting of the Institution in 1904, the use of gas engines was referred to in a paper by the author on "Internal Combustion Engines for Marine Purposes." At that time there was practically no information available with regard to them. Just then, however, Herr Emil Capitaine was carrying out experiments with his first boat, and a number of vessels have since been fitted which have shown very satisfactory results. It is thought that a description of them, and particulars of the results obtained, will be of interest to the Institution; Sir Wm. White having recently stated that he considers the gas engine is bound to play a most important part in marine engineering.

Before giving details of the different vessels, it may be well shortly to describe the way a gas engine works in conjunction with a gas producer, and consider the possible advantages and some of the difficulties that have to be overcome. The majority of small gas engines work on the Otto cycle, which has the advantage of requiring no special gas or air pumps; and this is the only type of engine that has been as yet tried for marine work. The gas producer which is generally used for moderate powers, works on the "suction" principle—that is to say, instead of the gas being generated by the combustion of fuel, by air and steam being forced through it under pressure, it is generated by the air being drawn through the producer—the whole of the apparatus working somewhat below atmospheric pressure. The advantage of this system is that neither a steam boiler working under pressure nor a gas container for holding the gas is required; and the further very important advantage for marine work is that there is no danger from leakage of gas from the producer. If leakage takes place, it is from the atmosphere into the producer itself.

There are so many combined plants, consisting of a gas engine working in conjunction with a suction gas producer, at work for stationary purposes, that it might appear that only very small alterations would be required in these plants to adapt them for marine propulsion. But, in addition to the great difference between almost all marine and land plants—viz., that of the quick and frequent variations of load which the smaller types of marine plants have to undergo—there are very many features which must be changed to adapt the gas engine and producer for boat work. In fact, it will be found that the principle of operation will be about the only thing which can be identical with the land plant, the details of the apparatus all having to be specially worked out for the new conditions. The producers for moderate sized powers are usually worked with anthracite coal; and where vessels are to be used on fixed routes, and the same class of fuel can always be obtained, anthracite or coke will be found to be the most suitable for moderate powers—it being too difficult to make a satisfactory small plant to work with bituminous coal. For larger powers, and for vessels that have to take up fuel at different ports, the producer must be capable of dealing with coal other than anthracite, which may be of a tarry or caking character.

The design of the producer capable of successfully dealing with bituminous or caking coal is a much more difficult problem than the anthracite producer. There are, of course, very many large land installations of pressure producers working with bituminous coal. But the apparatus for extracting the tar and other bye-products, as at present arranged, is far too cumbrous for marine work; and the marine producer to deal with this class of coal must be designed on entirely different lines, being arranged to consume the tar which is evaporated from the coal in the first stages of its heating. This has been done in some producers by taking the gas off at a comparatively hot part of the fire, instead of near the top of the new coal, as is usually the case with the anthracite producer. But there are plants now at work dealing successfully with bituminous caking coal which are fed by an under-type stoker, so that the new coal is forced into the hottest part of the fire and the tar which is driven out is at once burned. After the gas leaves the producer it must be first cooled, and as there will always be a certain amount of impurity, even when anthracite is used, it has to be thoroughly cleaned. This is usually done by passing the gas through a series of vessels, where it is scrubbed by its passage between layers of coke over which water is running.

It is frequently arranged that the cooling of the gas is effected by passing it over a water containing vessel, which acts as a generator for the steam required by the producer. But there are disadvantages in this method where the producer is not working at a uniform load, as the steam will not be generated until the producer has been working some time, and will continue when the engine has been stopped and when it is not required, and so cool the fire, causing the gas to be poor when the engine is again started.

The large space occupied by the ordinary coke scrubbers prohibits their use for marine work; and to meet this difficulty Herr Capitaine has arranged his plant to clean the gas, after it has been cooled, by the introduction of a very fine spray of water, which mixes with small particles of dust and other impurities in the gas, and forms a sort of fog. The gas in this stage is passed into a centrifugal apparatus, having a peripheral speed of 160 feet per second, which throws out the moisture and impurities, leaving a clean, dry gas to be drawn out by the engine. The percentage composition of this gas may be taken to be about as follows: Carbon dioxide, 6; carbon monoxide, 25; methane (CH), 1; hydrogen, 14; nitrogen, 54. It will be realized that the size of the producer for a given power is comparatively small when it is known that the area of the fire-grate necessary is only 0 05 square foot per horse power, whereas the average for an ordinary natural-draught steam boiler, burning 15 pounds of coal per square foot of grate area, would be 0.2 square foot. The depth of the fire will vary considerably with different qualities of coal used, but will not be usually more than two or three times the diameter of the fire-grate.

The author exhibited diagrams showing the different types of gas producers, and gave the following particulars in regard to them: Messrs. Dowson's arrangement of suction producer is designed for using anthracite coal. The majority of the smaller suction producers will be found closely to resemble this type. A firebrick lined steel casing is fitted with fire bars and a closed ashpit; and in the upper part of the casing a conical hopper is placed, with the usual valves for opening and closing to admit fresh charges of fuel. The gases come off the fuel at the base of the conical hopper, and pass through a steam generating pipe or vessel, and then away to the cooler and the scrubber. The producer is fitted with an outer casing, in which the air is heated, and mixes with the steam on its way to the ashpit. The Duff-Whitfield producer is arranged for working with bituminous fuel. In this producer, the tarry products which are evaporated from the new coal are caused to flow through the hottest part of the fire, and so are consumed before the gas passes away to the cooler. The Boutillier producer is arranged for working with bituminous fuel, which is supplied by an under-type stoker to the hottest part of the fire, so that the tar is at once decomposed, and cannot pass away with the gas. The principle upon which this producer works seems to be one of the best adapted for marine work. The Jan producer consists of a series of producers which are arranged to work in sequence; the gases of one which has been newly charged passing through another which has been at work some time, so that there are always some of the producers supplying tarry gas—the tar being consumed by one of the other producers in the later stages of the series. The heat losses in the producer itself are very small, as the whole plant can be so thoroughly lagged that practically there need only be heat passing away with the gas that is being generated. The loss from this cause may be very much reduced by using she heat to raise the temperature of air supplied to the producer. The heat efficiency, as given by Messrs. Dowson for their suction plant, is 90 per cent. As the result of a great many tests, the late Mr. Bryan Donkin gave the average heat efficiency of steam boilers at 66.7 per cent. To start up the Capitaine producer, a fire is lighted on the bars, and the producer is then filled with fuel, air being either drawn or blown through it by a hand or power driven fan. For a producer of about 50 to 100-horse power, 20 to 30 minutes should be sufficient to give good gas. This can be ascertained by lighting the gas which is being given off, and seeing that it continues to burn with the right sort of flame. The gas first produced will have very little hydrogen in it, and will not be very powerful, and it requires the steam generator to come into operation. The steam which is added to the air entering the producer strengthens the gas by the water being decomposed, and gives the percentage of hydrogen which is shown in the analysis above referred to. The gas produced in this way is of a comparatively slow-burning nature, and may be described as poor gas, to distinguish it from town gas and some of the other gases generated by pressure producers which have a larger proportion of hydrogen, such as water gas.

There is an advantage in this slow-burning gas, as it enables the engine to work with a high compression; thus giving a larger range of expansion, and consequently a high economy. The slow-burning nature also avoids the violent shocks which occur when more powerful gases are used, and so a smooth-running engine is obtained. The producer once being set to work, it will continue to generate gas in large or moderate quantities as the engine requires it, and sucks it from the producer. The producer will probably be giving the best gas at some-

what near it full capacity, but will continue to give good gas down to a small proportion of full load. At very light loads it is difficult to keep the fire hot enough to produce good gas, and special means must be adopted to keep the producer hot enough on these occasions.

Having now generally described the producer, the difficulties and advantages of adapting the gas engine itself to marine work will be considered. The one great disadvantage of the internal combustion engine is the necessity of setting it in motion before it will run automatically. For powers of less than 200 horse, it is preferable to employ reversing gear, keeping the engine always running in the same direction, or to use a reversing propeller. Compressed air is being employed for starting large engines, and when once the engine is fitted in this way the valve gear for running the engine in either direction does not amount to very much.

For moderate powers, a single-acting engine with a trunk piston is found most convenient, as the piston does not require to be water-cooled until one about 2 feet in diameter is employed. A single cylinder of 20 inches diameter and 2 feet stroke, running at 120 revolutions per minutes, will give about 100-horse power, taking the average working pressure at about 80, which is less than the figure often obtained. The same sized cylinder, working as a double-acting cylinder, would, of course, double the horse power; but, besides the additional valves, which must be an exact duplicate of those required for a single-acting engine, there is the complication of the water-cooled piston and rod. For small plants of from 100 to 200-horse power, a small auxiliary internal-combustion motor, driven by oil or some other fuel, is found most convenient for blowing up the producer, for starting it, and also for starting the main engine. For larger powers in vessels where steam capstans and steering gear are fitted, it is thought that the best plan will be to employ an auxiliary boiler, which can be heated by the gas when the whole plant is at work, and can be used independently to drive the various auxiliary and starting engines when the producer is not alight.

The average heat efficiency of steam boilers is taken at about 66 per cent. Professor Capper has stated that the theoretical maximum thermal efficiency of the steam engine is only 30 per cent., and only from 5 to 20 per cent. of the heat generated is ever turned into useful work. In the case of the gas engine, the theoretical efficiency is about 80 per cent., and in practice 25 to 30 per cent. of heat developd in the cylinder is turned into useful work. For vessels fitted with small power compound condensing engines of less than 100-horse power, the fuel consumption will be from 2 to 3 pounds per indicated horse power. For gas plants of this power, the fuel consumption will be less than 1 pound per indicated horse power. For larger powers of not less than 500-horse power the economy will not be quite so marked, but will be about as follows: Steam plant (say) 1.6 pounds per indicated horse power; gas plant (say) 0.8 pound ditto. At this figure of one-half, the gas plant should be well worthy of adoption from an economical point of view, as, in other words, the same coal will do double the work. The stoking and the cleaning of the fire of the producer are much less than would be required for a steam boiler of the same power; the stoking being practically automatic, and practically the whole fuel other than the clinkers is consumed. From the plants made, and from designs that have been got out for moderate powers, it would appear that the space occupied by the gas generator and engine is about the same as the steam plant; but for large powers, where a double-acting gas engine is employed, the weight will be considerably less, as the engine will be about the same weight as the steam engine, and the producer will be very much lighter than the boiler.

The type of engine adopted by Herr Capitaine for his small powers is built with a plate frame, no casting being employed in the engine other than the cylinder itself. A light engine is thus obtained, and there is no danger of breakage resulting from the very high pressures employed. The official report of the tests of the engine fitted to the vessel which ran in the reliability trials in the Solent last summer (which was named *Emil Capitaine*, after the inventor of the system), shows that this boat of 15 tons displacement ran at an average speed of 10 miles per hour for 10 hours, on a consumption of 412 pounds of anthracite coal. This consumption also includes the fuel which was consumed by the producer during the previous 12 hours, when it was not in active operation, but simply smouldering and keeping itself alight, the producer having been filled the night before the trial. The amount of fuel consumed in this way is very little, but it should be taken into account when making a consumption trial. Several tugs, boats and other vessels have been fitted with similar engines, and they are running on the Continent on the inland waterways; but, as far as is known, the *Emil Capitaine* was the first vessel fitted with a gas engine and producer to run in the open sea. Messrs. Deutz, the well known gas engine builders of Cologne, have fitted one of the large Rhine barges with two of their 2-cylinder land type engines and producers. The vessel is of 200 tons carrying capacity, and it is said to have given satisfactory results, running on the Rhine between Rotterdam and Cologne.

To determine the suitability of the Capitaine system for small powers, a canal barge has been fitted with a 2-cylinder 35-horse power engine, and has been sent on an extended trip over the English canals. She left Brentford in charge of Mr. B. Dunell on the 3d of January, fully loaded herself, and towing two ordinary canal barges, which she took to Birmingham. After giving various demonstrations there, she proceeded to Manchester, and after making further trials there, worked her way back to the Thames at Oxford, returning to Chiswick at the end of February. The total fuel consumed on the round trip and the various demonstration runs she made at the different places was 5 tons 1 cwt., the engine having been under way for 40 days. The only difficulties experienced on the trip were due to the shallowness and the bad state of many of the canals. The particular barge to which this machinery was fitted was originally built to be propelled by steam, and it is interesting to note that a considerable gain has been effected in cargo space by the substitution of the gas plant. In addition to the high economy which can be obtained with this plant for canal barge propulsion, there is the great advantage over the oil of absence of smell—an objection which the barge owners state prevents the adoption of the oil motor for their work, as the cargo they frequently carry would be damaged by taking up the smell of the oil. It has been suggested that the exhaust from the engine would be dangerous in passing through canal tunnels. No difficulty from this source was experienced; and, indeed, it is difficult to see why there should be any more danger than from the carbonic acid gas given off by the boiler of a steam barge.

To demonstrate the possibility of using gas plants for large powers, Messrs. Wm. Beardmore & Co., who are joint owners with the author's firm of the British Capitaine patents, are constructing sets of engines of 500 and 1,000-horse power to run at a speed of about 130 revolutions per minute. The 500-horse power set is generally of similar construction to the smaller sizes; the framing consisting entirely of steel plates arranged to transmit the stresses direct from the crank-shaft bearings to the cylinder heads. Cam-shafts for operating the inlet and exhaust valves are placed on each side of the cylinders, the valves being operated by rocking levers, so that when the cylinder head is removed, free access can be obtained to withdraw the pistons. The 500-horse power engine consists of five cylinders, each capable of developing 100-horse power. The reason for adopting this size of unit has been that the largest piston is being employed which it is thought safe to use without water-jacketing it. The 1,000-horse power engine has the same diameter of cylinder and length of stroke; but the engine is double-acting, and the pistons are necessarily water-cooled. These large engines are started by admitting compressed air or gas through special starting-valves, and reversing is effected by an arrangement for shifting the cams for operating the valves to the right relative position for running the engine in the opposite direction. Compressed air or gas is admitted to make the engine give the first few revolutions in the required direction; the engine being uncoupled from the propeller shaft by means of hydraulic clutch or coupling for the short time while reversing is taking place.

The producers for these engines are arranged to work with bituminous fuel; the producer being stoked from the top, and the gas drawn off from the hottest zone of the producer. The green fuel on the top is pre-heated by the hot coal underneath, and the tarry products are carried through the incandescent fuel. A special feature of the producer is the arrangement for preventing the caking of the fuel and the formation of cavities, which are so difficult to avoid when bituminous fuel is employed.

The author exhibited a diagram showing the machinery space of the 7,000-ton cargo steamer recently constructed by Messrs. Beardmore & Co., Limited, and an alternative arrangement which has been got out by Mr. W. W. May (Messrs. Beardmore & Co.'s engineer) to fit vessels of the same power with gas engines and producers. With this latter arrangement a saving of 13,000 cubic feet of space is effected, besides a considerable saving in weight. The producers themselves are so small that they can be placed partially above the engines. It has been suggested that trouble would occur from the gases emanating from the producer in the confined spaces on board ship. But, if proper ventilating arrangements are made, there should be no trouble from this cause—indeed, the crew of the gas barge already referred to frequently slept in the producer room during the trial, which was conducted in very cold weather. Though this course is not to be recommended, it indicates that there need be no danger.

With a view of ascertaining what results may be expected with producer gas, inquiries have been made of a number of large gas engine manufacturers, and it appears that there are many engines of 250 to 400-horse power per cylinder running regularly every week from Monday morning to Saturday afternoon without a stop. The Premier Gas Engine Company give an instance of an engine which has made a run of 51 days without a stop; the previous run being 49 days.

From the various physical changes which take place within the cylinder of an internal combustion engine, it is evident that it cannot well compete with the steam engine so far as continuous running without cleaning and adjustments is concerned; but, from results that are being obtained in everyday use, it is submitted that the reliability is now so good that there need be no hesitation in adopting them on this account.

The By-Product Coke Industry.

Iron Age says that the larger place of the by-product coke oven in the United States is indicated by the record of the coke industry for 1905. From retort coke ovens the output was 3,462,348 net tons last year, as against 2,608,229 tons in 1904. Yet 1905 did not measure up to the proportion of by-product coke produced in the preceding year. The percentage was 10.74, as compared with 11 per cent. in 1904, 7.4 per cent. in 1903 and 5.5 per cent. in 1902. Gauging the retort oven movement by the number of ovens building, there was a marked subsidence in 1905. Against 832 by-product ovens building at the close of 1904, out of a total of 4,430 then under construction, the number was 417 out of a total of 4,751 at the close of 1905, a numerical reduction of 50 per cent., and a decline from 18.8 per cent. of the total to 8.8 per cent.

The progress of by-product coke seems to be in waves. A large building movement such as that which added 940 ovens at the Lackawanna Steel Company's plant at Buffalo is rare. The success of the earlier plants has been well enough attested by the fact that nearly all have been increased, in most cases being doubled; but the interests committed by heavy investments to the beehive oven are not forsaking it. While the exhaustion of Connellsville fuel has been a subject of discussion in recent years, the coals of the Connellsville basin, and adjoining Pennsylvania fields, as well as those of Virginia and West Virginia, will be the backbone of the metallurgical fuel supply of the country for many years to come. The fact that gases escape into the air that might be utilized in the production of tar, ammonia and other substances, may strike the visitor to the coke ovens as proof of the wastefulness of the manufacturing method; but that does not signify that there would be economy in the substitution of the by-product oven on a large scale where coal is coked at or near the mine, and with the cost of the by-product oven 8 or 9 times that of the beehive oven. So, while our consuls in Europe, learning the German and Belgian practice, will continue to make the discovery that useful gases are being wasted in enormous volumes by our beehive ovens, and an occasional newspaper or magazine writer will point our coke manufacturers to the way of profit, there will continue to be the same discrimination in the erection of by-product plant that has marked the course of that industry thus far.

It is well recognized by the builders of by-product ovens that their profitable employment depends on a not too rapid development of the industry. The ability of the United States to absorb the by-products is a matter that has already demanded careful consideration. If the market for tar and ammonia be glutted, prices will fall to a point at which the profit in their manufacture at coke plants will disappear. The profitable disposal of illuminating gas, moreover, depends upon proximity to cities. Already there has been important progress in enlarging the yield of by-products and the process of manufacture has been carried considerably farther than the crude state at the original distilling plant. The establishment of a chemical industry, which shall utilize the by-products of tar, as is done in Germany, and supply the domestic demand for aniline dyes and other articles now imported at an enormous annual outlay, is a development from which much may be expected in time.

Meanwhile the advance of the by-product oven in metallurgical lines will be chiefly in connection with plants built at a distance from coal mines, and whose location is dictated by low cost of ore transportation. With important coking coals largely preempted by steel making interests, to whom the most economical production is with their extensive beehive plants, the by-product oven's natural alliance in the immediate future will be with furnaces producing irons for foundries and iron rolling mills, as well as merchant furnaces producing steel-making iron. But more important than the metallurgical field is that which awaits the by-product oven in supplying smokeléss fuel as well as illuminating gas to large cities. Not only the well-defined limits of the anthracite coal supply but the growing public feeling on the subject of smoke prevention will lead to an increasing use of coke for domestic fuel. The economies attending the manufacture of this coke in by-product ovens and the city market that will be found for the gases, not only for illumination but for power, make the combination one that will have increasing attraction for capital.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. O. O. THWING has been appointed engineer to the Western Gas Construction Company, of Fort Wayne, Ind. There can be no doubt of the ability of Mr. Thwing to take care of the responsibilities attaching to his new position, and we wish for him the very best of success.

MR. FRANCIS SHUNK BROWN informs us that "there will be a meeting in the estate of the Acetylene Light, Heat and Power Company," on the 1st prox., at his offices, No. 1001 Chestnut street, Philadelphia, Pa. The meeting is called for 3:30 P.M.

MR. C. C. HARTPENCE, who since 1891 has been engaged in the business of consulting engineer, with offices in 126 Liberty street, New York city, has accepted a responsible place with the firm of F. H. Lummus Sons' Company, manufacturers of cotton ginning machinery, Columbus, Ga. Mr. Hartpence, it may be remembered, was formerly on the engineering staff of the New Amsterdam Gas Company, this city.

MR. L. C. HAMLINK, President and General Manager of the Gas Bench Construction Company, of St. Louis, Mo., which has succeeded to all the rights of the St. Louis Gas Construction Company, informs us that the entire matter means and is only a change in its corporate title, the former one having not been clear enough in indicating the actual business of the Company. There has been no change in its management, and its offices are as before in the Linmar Building, St. Louis.

WRITE to the General Gas Light Company, of Kalamazoo, Mich., for a copy of its photographic views with appropriate text, descriptive "of outdoor lighting installation, showing various methods followed and representative types." Of course, both pictures and letterpress have to do with the worth and merit of the "Humphrey Outdoor Gas Arc Lamp," the success of which is little short of phenomenal.

THE William M. Crane Company, of New York, is out with a handsome catalogue (No. 30) descriptive of its well-known Vulcan gas heating appliances.

THE Government, through Secretary Shaw, has offered the Boston (Mass.) Gas Company $250,000 for the property on which the North End works of the Company formerly stood. The plot, which is bounded by Prince, Commercial and Hull streets, contains 71,000 square feet, and the Government proposes to construct thereon a suitable building for the purposes of the appraisers' stores department.

THE employees of the commercial department of the Boston Consolidated Gas Company had a most enjoyable outing some days ago on Peddock's Island. A steamboat ride—in-and-out—a baseball game and other athletic sports, an edible and well-served fish dinner, some more or less intelligible discourses, and a plethora of good fellowship, marked the day's outing. The affair was originally planned by the men themselves, they to bear the expenses of it, but when all the arrangements had been completed the Gas Company directed that all bills on such account be sent to it for payment.

THE incorporators of the Quogue (L. I.) Gas Company are returned as follows: David C. Townsend, Charles H. Smith, W. M. K. Olcott, of New York city; Abram S. Post, Erastus F. Post and Henry Gardener, of Queens, L. I., and James K. Burnham, of Kansas City, Mo.

MR. C. H. DUNBAR, Superintendent of the Houston (Tex.) Gas Light Company, seems to have done the right thing at the right time, as the following paragraph from an editorial in a recent issue of the Houston

Chronicle would indicate: "* * * The Houston Gas Light Company took on new life with its reorganization. The lethargy that marked the past was shaken off, mains have been extended, the capacity of the plant practically doubled, and through a special line of mains the public is supplied with a most superior quality of gas. * * * The evidence of the public appreciation of the Company's progress is amply borne out in the vastly increased amount of business that has followed the adoption of the course that means the supplying of a high grade gas for illumination and fuel, steady pressure, reasonable rates and courteous service."

WE are informed that the proprietors of the Sault Ste Marie Gas and Electric Company have awarded a contract for apparatus for the plant which it is proposed to erect on a plot just west of the Hickler Bros. shipyard. The houses are to be constructed to hold apparatus up to a daily output of 300,000 cubic feet eventually, but the initial capacity is put at 150,000 cubic feet. Mr. J. M. Gregory has been appointed Superintendent of Construction, and as we understand it he will act as Resident Superintendent when the plant is completed, which will be early in the spring. The contractors are the Stacey Manufacturing Company, of Cincinnati.

THE proprietors of the Sioux Falls (S. D.) Gas Light Company have put the selling rate at $1.25 per 1,000 cubic feet, a concession of 25 cents from the former schedule.

THE contract awarded to the Western Gas Construction Company by the proprietors of the Columbia (Pa.) Gas Company for a new water gas plant at that point, stipulates that the plant is to be in running order by December 1st. When the supply is turned on the Company has pledged itself to reduce the selling rate from $1.50 to $1.25 per 1,000 cubic feet. Superintendent Meyers is in great feather over the way his Directors have heeded his pleas.

MR. R. C. HUNT, formerly in service of the San Diego (Cal.) Gas and Electric Company, has joined the engineering staff of H. M. Byllesby & Co. His headquarters will be in the Chicago offices of the Byllesby Corporation.

ANOTHER addition to the Byllesby's engineering staff is Mr. Samuel C. Shaffner, formerly Engineer and General Manager of the Illumination Company, of Mobile, Ala.

THE additions to the distributing system of the Citizens Gas and Electric Company, of Council Bluffs, Ia., amount to about 5 miles of mains. This will bring the total mileage up to 39.

THE Union Gas and Electric Company, now in control of the properties and business of the Cincinnati Gas and Electric Company, has elected the following officers: Directors, N. G. Kenan, C. H. Rowe, Reuben Holden, H. A. Everett, J. T. Carew, Archibald S. White, George W. Young, Oscar Gubleman, A. B. Leach, J. M. Gill and Joseph Heard. President, N. G. Kenan; Secretary, Theodore Clauss; Treasurer, John C. Campbell.

WE understand that capitalists of Fort Wayne, Ind., have arranged for the sonstruction of a plant at Auburn Junction for the purpose of supplying gas to the residents of the growing districts of Auburn and Garrett, Ind. The franchise under which the business is to be carried on restricts the maximum selling rate to $1.20 per 1,000 cubic feet.

THE Muncy (Pa.) Council has under consideration an application from certain parties for the right to manufacture and sell gas in Muncy and Hughesville.

THE State Commission of Gas and Electricity has handed down its decision in respect of the hearing for a reduction in gas rates in Syracuse, N. Y. The decision also regulates the price that may be charged for electric currents for lighting use, the new schedules to become effective October 1st. Gas, 95 cents per 1,000 cubic feet; electricity, each street lamp maintained on public account, $68 per annum; current on commercial incandescent account, 9 cents per kilowatt hour until October 1st, 1907, after which date the rate is to be 8 cents.

MR. HENRY JACKSON, formerly Engineer to the Steubenville (O.) Traction and Light Company, has been appointed Superintendent of the Utah Gas and Coke Company.

IT is said that construction work on the plant of the Hyattsville (Md.) Gas and Electric Company, will be commenced forthwith, under the direction of Mr. T. G. Kniese.

THE Gas Machinery Company, of Cleveland, O., has recently perfected some improvements in an aqua ammonia still construction, which experimentation had been carried on for some time. On the verification of the experimental results obtained, the Machinery Company has been awarded the contract for the construction of a 48-inch machine, to be placed in the works of the Indianapolis Gas Company. This action would seem to indicate growing interest on the part of gas engineers to make bye-products' recovery a more important object than ever.

THE Wallingford (Conn.) Gas Company reports 1906 as the banner year in its history respecting the placing of gas cookers and kindred appliances. The Company is now completing the comprehensive additions to its main system that were planned last spring.

THE issues of the Los Angeles (Cal,) *Graphic*, dated respectively, August 11th, 18th and 25th, contain much interesting matter in connection with the exploitation of the Peoples Gas and Coke Company of the named city. It is a rather difficult matter to state precisely what the conditions are that govern the antics of the "capitalists" who would deliver Los Angeles and its people from the lighting bondage to which the old Company has subjected them! Alas! and alack! The old Company meanwhile is going along smoothly in its liberal methods of catering amply and well to the artificial lighting needs of the residents of the Gem City of the Pacific Coast.

A FIRE, which at one time had a very serious aspect, occurred some days ago in the plant of the Peoples Gas Light and Coke Company, Chicago, is mentioned here and now merely to show the efficiency displayed by the Company's fire brigade. The flames were extinguished in less than 20 minutes, and the damage done was less than $1,000, all told. The locality is a dangerous one under such conditions, for the works (West 22d street and Center avenue) are hemmed in by huge lumber yards and other industrial concerns, the business of which is of a nature well inclined to feed flames. The fire originated in a coke heap.

THE betterments on the plant of the New Haven (Conn.) Gas Company will be completed by the end of November. These betterments, which have taken up much time and involved the expenditure of large sums of money, put the Company in possession of one of the best equipped plants in the country.

THE old plant of the Citizens Gas Light Company, of Quincy, Mass., has been relegated to the dismantling stage. Quincy supply comes now direct from Boston.

THE Greyson (Cal.) Gas and Electric Supply Company has been incorporated by Messrs. A. E. Granpuer, W. Mayer and Albert Mayer. It is capitalized in $25,000.

MR. O. A. FARRAR, formerly Engineer of the Allis-Chalmers Company, has joined the engineering staff of the H. M. Byllesby Company, and has charge of the reconstruction work of the large, modern electric lighting plant which the Byllesby Company is erecting at Mobile, Ala.

WORK on the plant of the Owatonna (Minn.) Gas, Electric and Heating Company, is progressing rapidly. The holder, which is rated to store 60,000 cubic feet, will be completed by November 1st.

THE voters of Elizabeth, N. J., will, at the general election next November, ballot on the question as to whether or not the authorities shall be authorized to construct and operate a municipal lighting plant.

THE Little Rock (Ark.) Company is making notable extensions to its main system.

THE Directors of the Safety Car Heating and Lighting Company have declared a regular quarterly dividend of 2 per cent., and an extra dividend of 2 per cent., both payable the 1st prox.

MR. ALBERT VAN HESS, formerly with the Manistee (Mich.) Company, will construct the new gas plant (acting in the capacity of erecting engineer) for Auburn, Ind.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

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ELBERT P. CALLENDER,
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NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, SEPTEMBER 17, 1906.

The Market for Gas Securities.

Changes in the local gas share market were few last week. Consolidated held at 139 to 140, and dealings were meager. The undertone, however, was strong. Brooklyn Union was in some demand, but trading was light. A feature of the market was a scattering inquiry for bonds, and some sales were made at figures well in excess of those last reported.

Peoples, of Chicago, was steady, and there can be no doubt about it that that security is getting much notice from investors of the conservative sort. Baltimore Consolidated is 82 bid, and Cincinnati Gas and Electric readily sells at 102 to 103.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

SEPTEMBER 17.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	139	140
Central Union Gas Co.—				
1st 5 s, due 1972, J. & J.	3,000,000	1,000	101	104
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	..	105
Mutual	3,500,000	100	190	235
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	99	101
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1s Mtg. Gold Bds. 5 p. ct.	1,000,000	..	98	104
Northern Union— 1st 5's, due 1927, J. & J.	1,250,000	1,000	101	103
New York and East River— 1st 5 s, due 1944, J. & J.	3,500,000	1,000	108	111
Con. 5's, due 1945, J. & J.	1,500,000	..	104	110
Standard	5,000,000	100	140	160
Preferred	5,000,000	100	155	175
1st Mtg. 5's due 1931, M. & N.	1,500,000	1,000	104	108
The Brooklyn Union	15,000,000	1,000	125	130
1st Con. 5's, due 1948, M. & N.	15,000,000		107	..
Yonkers	999,650	500	130	..
Out-of-Town Companies.				
Bay State	50,000,000	50	5/16	¾
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	..	65
" 1st Mtg. 5's	509,000	1,000	95	100
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	9	10
" " Bonds, 5's	5,250,000	1,000	75	80
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	106¾
Cincinnati Gas and Electric Co.	29,500,000	100	102	103
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	90	..
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	..	95
Preferred	3,096,500	100	107½	108
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	82	87
Mortgage, 6's	3,500,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	..	..	100
Detroit City Gas Co.	5,000,000	50	..	50
" Prior Lien 5's	4,618,000	1,000	..	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	95¾	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	..	110	112
" Bonds, 5's	10,500,000	..	107½	108½
Indianapolis	2,000,000	..	60	70
" Bonds, 5's	2,650,000	..	104½	105
Jackson Gas Co	250,000	50	82	..
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	86
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	.	105
Preferred	2,500,000	100	95	110
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind.	1,000,000	100	..	60
Bonds	1,000,000	1,000	60	65
Louisville	4,570,000	50	142	145
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	85	87
Massachusetts Gas Companies of Boston	25,000,000	100	58⅛	58⅝
Preferred	25,000,000	100	88⅛	88¾
Montreal, Canada	2,000,000	100	218	218¾
Nashville Gas Lt. Co.	1,000,000	100	110	..
Newark, N. J., Con. Gas Co.	6,000,000	..	56	58
Bonds, 6's	6,000,000	..	137	138
New Haven	2,000,000	25	200	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	90	90½
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	..
Rochester Gas & Elec. Co.	2,150,000	50	58	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	104½	105½
San Francisco, Cal.	15,800,000	100	..	..
St. Joseph Gas Co. 1st Mtg. 5's	751,000	1,000	22	..
St. Paul Gas Light Co	1,500,000	100	45	47
1st Mortgage 6's	850,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	96¼	..
Syracuse, N. Y.	1,975,000	100	50	55
Bonds	2,047 000	1,000	102	..
Washington, D. C	2,500,000	20	295	300
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	..	..	..
Wilmington, Del	600.000	50	230	..

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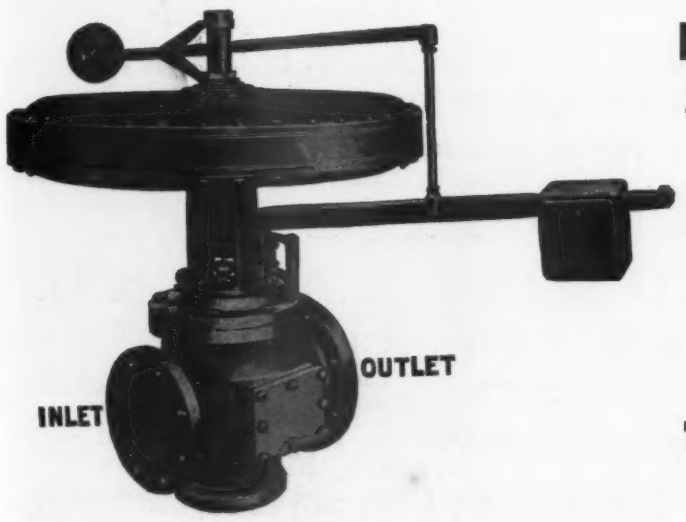

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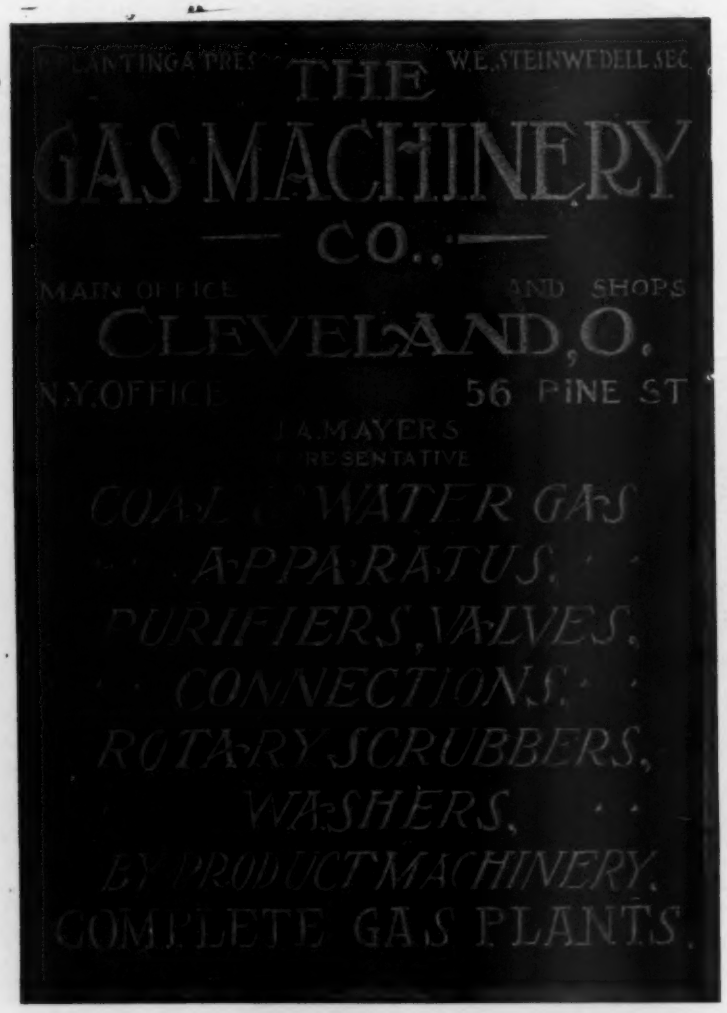

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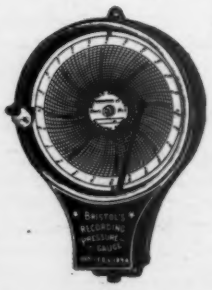

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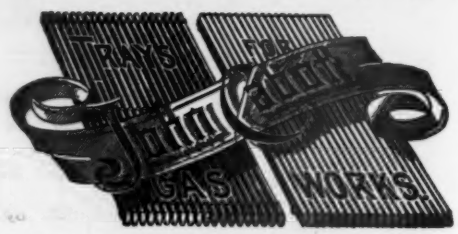

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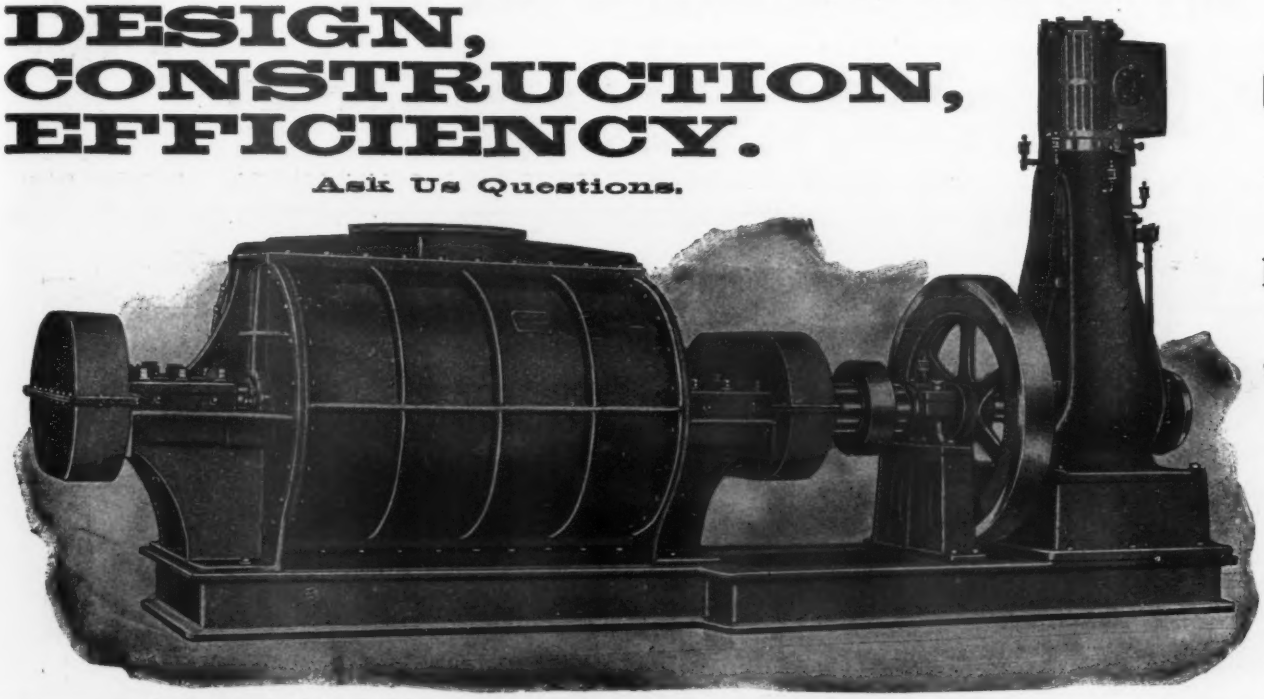

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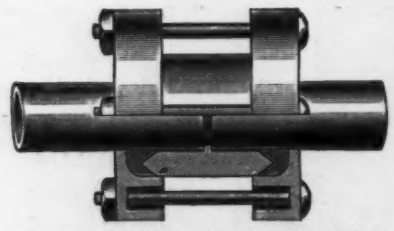
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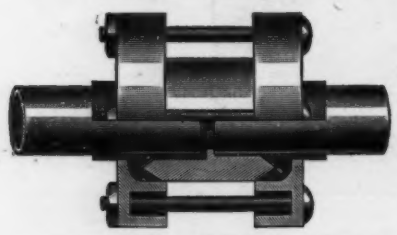
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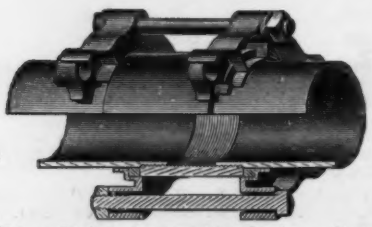
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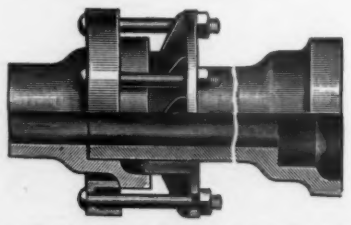
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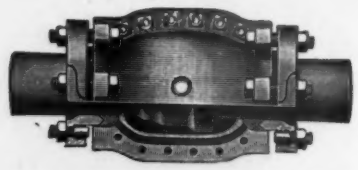
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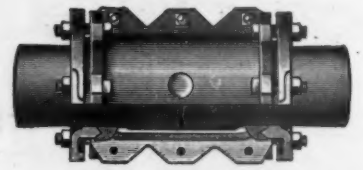
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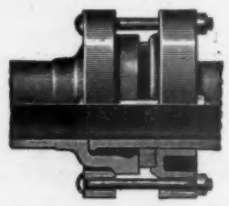
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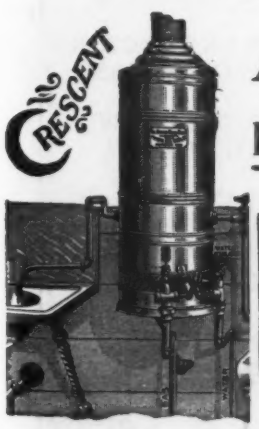

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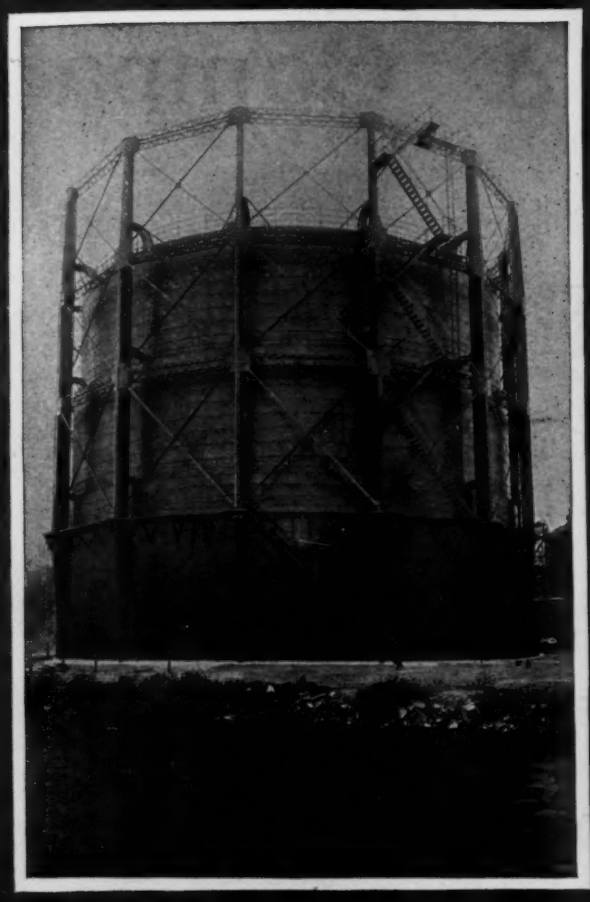

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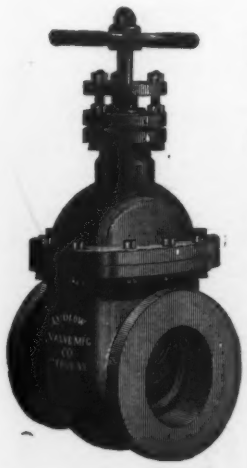

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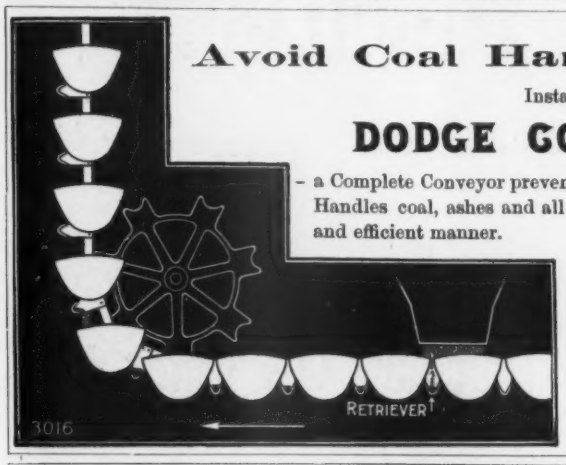

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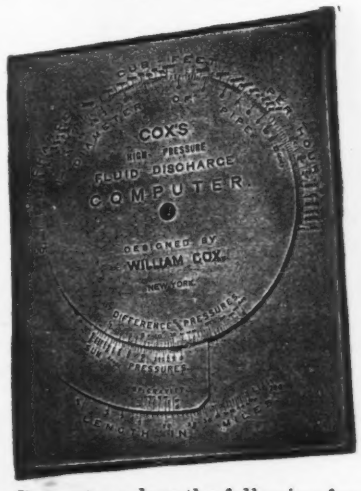

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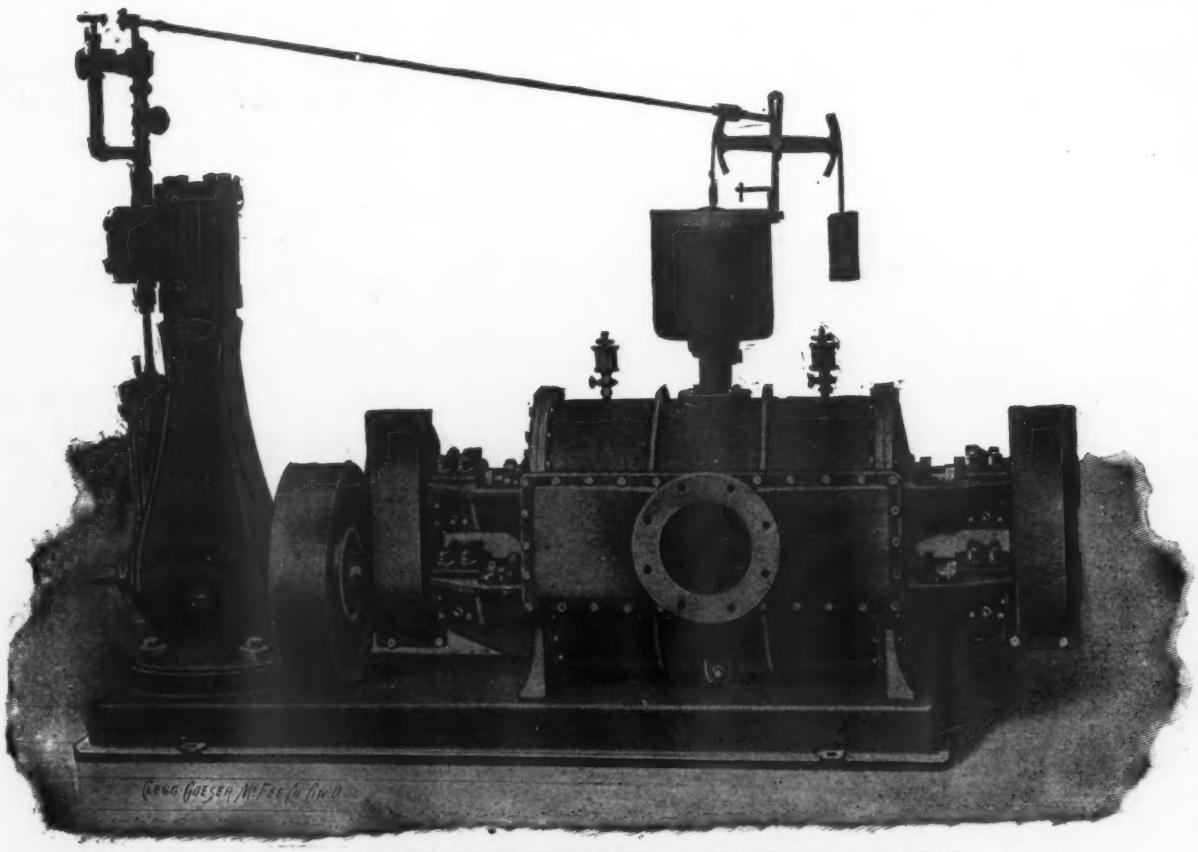

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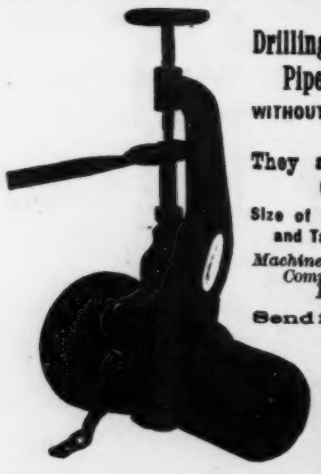

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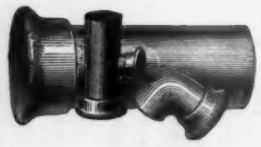

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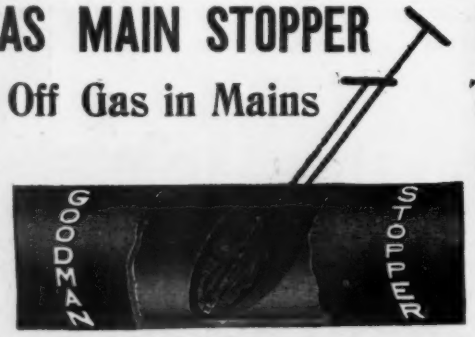
FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF

Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

SAFETY GAS MAIN STOPPER COMPANY,

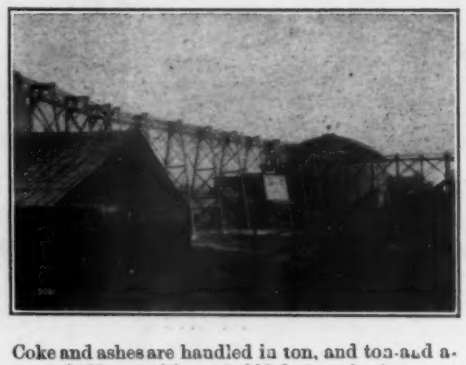
For Shutting Off Gas in Mains Temporarily during alterations and repairs. : : : :

Any size gas main can be shut off in 30 seconds. : : :



STOPPERS SENT ON TRIAL.

Address: SAFETY GAS MAIN STOPPER CO., 552 E. 135th St., New York City.



Coke and ashes are handled in ton, and ton-and a-half quantities at 1,000 feet a minute.

TELPHERAGE FOR GAS WORKS.

Our Telpherage System is a boon to gas works. For instance coal, coke, ashes--any material in any condition - can be handled at great speed, and with unapproachable economy because one machine and one operator do the work. The picture shows part of the plant we recently installed at the Lowell Gas Light Co., Lowell, Mass.

State your case—and ask for booklet 53.

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The Dodge Coal Storage Co.

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New York—299 Broadway.
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Pittsburgh—1501-2 Park Building.
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Chollar's System of Gas Purification.

THE PURIFIED GAS REVIVES THE FOULED OXIDE.

FIELD'S ANALYSIS

For the Year 1905.

An Analysis of the Principal Gas Undertakings in England, Scotland and Ireland. Being the 37th Year of Publication.

COMPILED AND ARRANGED BY **JOHN W. FIELD,**

Secretary and General Manager of The Gas Light and Coke Company, London.

PRICE, $5. FOR SALE BY

A. M. CALLENDER & CO., 42 PINE ST., NEW YORK CITY.

AMERICAN METER CO.,

NEW YORK, ST. LOUIS, PHILADELPHIA, SAN FRANCISCO, CHICAGO,

Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

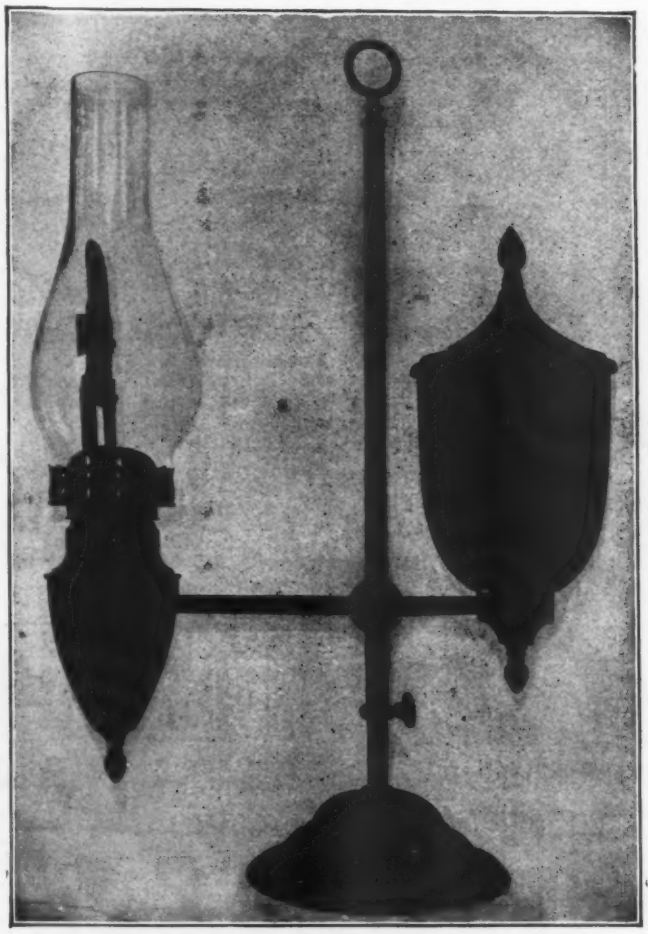
OCTOBER, 1906.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.
Mon.	1	No L.	No L.
Tue.	2	No L. FM	No L.
Wed.	3	No L.	No L.
Thu.	4	6.10 PM	8 10 PM
Fri.	5	6 10	8.40
Sat.	6	6.10	9.10
Sun.	7	6.00	9 50
Mon.	8	6.00	10.30
Tue.	9	6.00	11.20
Wed.	10	6.00 LQ	12.10 AM
Thu.	11	6.00	1.00
Fri	12	6.00	2.00
Sat.	13	6.00	3.10
Sun	14	5.50	5.10
Mon.	15	5.50	5.10
Tue.	16	5.50	5.10
Wed.	17	5.50 NM	5.10
Thu.	18	5.50	5.10
Fri.	19	5.50	5.10
Sat.	20	5.50	5.10
Sun.	21	5.40	5.20
Mon.	22	8.20	5.20
Tue.	23	9.20	5.20
Wed.	24	10.30 FQ	5.20
Thu.	25	11.30	5.20
Fri.	26	12.40 AM	5.20
Sat.	27	1.40	5.20
Sun.	28	2.40	5.30
Mon.	29	3.40	5.30
Tue.	30	No L.	No L.
Wed.	31	No L. FM	No L.

TOTAL HOURS DURING 1906.

By Table No. 1.

	Hrs. Min.
January	223.40
February	190.40
March	192.10
April	167.00
May	152.20
June	142.10
July	150.20
August	157.40
September	170.00
October	185.10
November	201.40
December	214.00
Total, yr.	2146.50



THE ELLIOTT KEROSENE STANDARD PHOTOMETER LAMP.

✻✻✻

10-Candle Power.

✻✻✻

This lamp is a perfect substitute for the 10-candle Pentane Lamp hitherto used, and has the following advantages:

1st. It uses Standard Kerosene Oil (Pratt's Astral Oil or equivalent).

2d. It is remarkably steady. Will burn 24 hours continuously with less than 2 per cent. variation.

3d. It is much less dangerous than Pentane, which is a kind of gasolene.

4th. It is not easily affected by air currents in the photometer room.

5th. Since the lamp may burn continuously, the candle power of gas may be taken at any moment, if necessary. This insures steady illuminating power without waste of carburetting material.

6th. The first cost of the lamp brings it within the reach of even small gas works.

7th. Costs much less to maintain than a Pentane lamp or sperm candles doing the same service.

8th. Is not affected by the weather.

PUBLIC LIGHTING TABLE.

OCTOBER, 1906.

Day of Week.	Date.	Table No. 2. New York City. All Night Lighting. Light	Extinguish.
		P. M.	A. M.
Mon.	1	5.30	5.00
Tue.	2	5.30	5.00
Wed.	3	5.30	5.00
Thu.	4	5.30	5.00
Fri.	5	5.30	5.00
Sat.	6	5.30	5.00
Sun.	7	5.30	5.00
Mon.	8	5.20	5.10
Tue.	9	5.20	5.10
Wed.	10	5.20	5.10
Thu.	11	5.20	5.10
Fri.	12	5.20	5.10
Sat.	13	5.20	5.10
Sun.	14	5.20	5.10
Mon.	15	5.10	5.20
Tue.	16	5.10	5.20
Wed.	17	5.10	5.20
Thu.	18	5.10	5.20
Fri.	19	5.10	5.20
Sat.	20	5.10	5.20
Sun.	21	5 10	5.20
Mon.	22	5.00	5.30
Tue.	23	5.00	5.30
Wed.	24	5.00	5.30
Thu.	25	5.00	5.30
Fri.	26	5.00	5.30
Sat.	27	5 00	5.30
Sun.	28	5.00	5.30
Mon.	29	4.45	5.35
Tue.	30	4.45	5.35
Wed.	31	4.45	5.35

TOTAL HOURS DURING 1906.

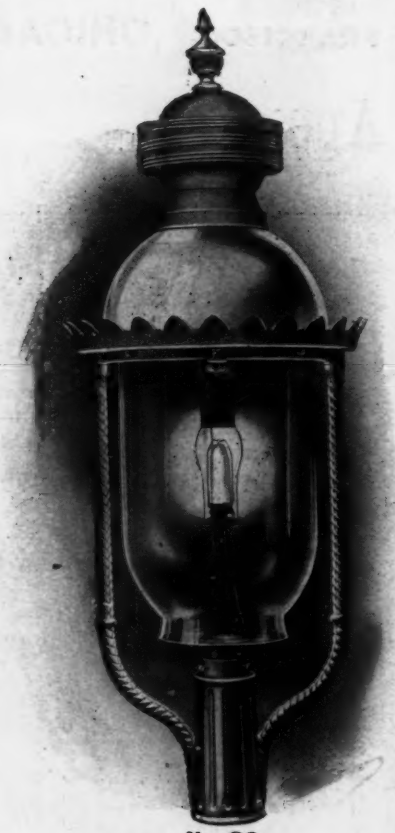
By Table No. 2.

	Hrs. Min.
January	423.20
February	355.25
March	355.35
April	298.50
May	264.50
June	234.25
July	243.45
August	280 25
September	321.15
October	374.30
November	401.40
December	433.45
Total, yr.	3987.45

NEW YORK, 318 West 42d Street.
BOSTON, 820 Beacon Building.
PHILADELPHIA, Broad and Arch Streets.
ST. LOUIS, 712 Roe Building.
CHICAGO, 218 La Salle Street.
SAN FRANCISCO, 512 Oak Street.

WELSBACH STREET LIGHTING COMPANY

....OF AMERICA....



No. 36.

Controls and Operates the **Welsbach System of Street Lighting,**

Which includes its specially DESIGNED and PATENTED BURNER for PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others interested in Municipal and Outside Lighting.

No. 38.

THE NEW NO. 7 WELSBACH DINING ROOM FIXTURE.

PRICE, EACH, COMPLETE, WITH SHADE, FRINGE, MANTLE AND CHIMNEY, $14. PER DOZ., $150. DISCOUNT, 50 PER CT.

Standard Length, 30 inches.
The New No. 7 Welsbach Dining Room Fixture, when ordered, will be sent complete, as follows:

1 No. 7 Harp Fixture and Brass Crown finished in Brushed Brass.
1 No. 66 Welsbach Burner (high candle power).
1 No. 4 Pilot By-pass.
1 No. 4197 Mantle — Intensive Brand.
1 No. 306 Chimney (air hole).
1 Fourteen-inch GREEN Art Glass Shade, with six-inch Green Beaded Fringe.

VARIATIONS.

Finished in oxidized copper, oxidized brass, etc., 25 cents extra.

Shades in Ruby and Green--Ruby, Amber and other colors, without extra charge.

Special colors require a few days extra time to fill orders.

Green Shades will be shipped unless otherwise ordered.

This fixture is being largely used by Gas Companies as a dining room fixture at the popular retail price of $10 complete, and is a great favorite for moderate sized two and three-story residences. In popularity and price it is unequalled.

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Salesrooms in All the Principal Cities of the United States.
Factories:
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For the Six Months Ending July 1st, 1906, has been Awarded Contracts for 25 Sets of

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PARTIAL LIST OF PLACES:

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Council Bluffs, Ia. (2d contract).	**Muskegon, Mich.**	**Waterville, Me.**
Seattle, Wash. (2d contract).	**Nazareth, Pa.** (2d contract).	**Washington, D. C.** (3d contract).

TOTAL SETS TO JULY 1, 1906, - - - - - 618

TOTAL DAILY CAPACITY TO JULY 1, 1906, 488,930,000 CUBIC FEET.

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Established 1858. Incorporated 1890.
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J. H. Gautier & Co.

Greene & Essex Streets,
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AMMONIA.

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An Analysis of the Principal Gas Undertakings in England, Scotland and Ireland. Being the 37th year of publication. Compiled and arranged by JOHN W. FIELD, Sec'y and Gen. Mgr. of The Gas Light and Coke Company, London. Price, $5. For Sale by
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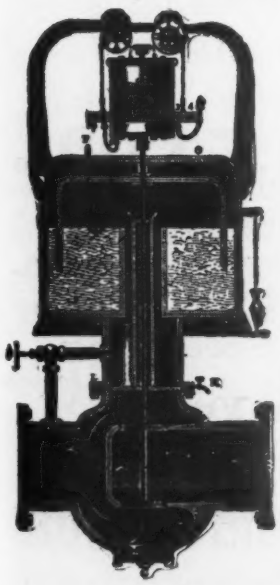

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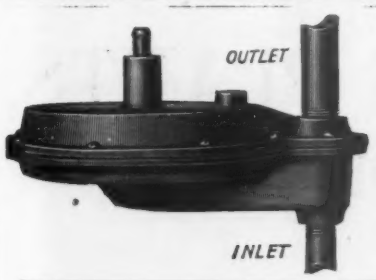

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Our Governors Reduce 30 or 40 Pounds Pressure to 2 Inches Water Pressure.

WE MAKE ALL SIZES OF

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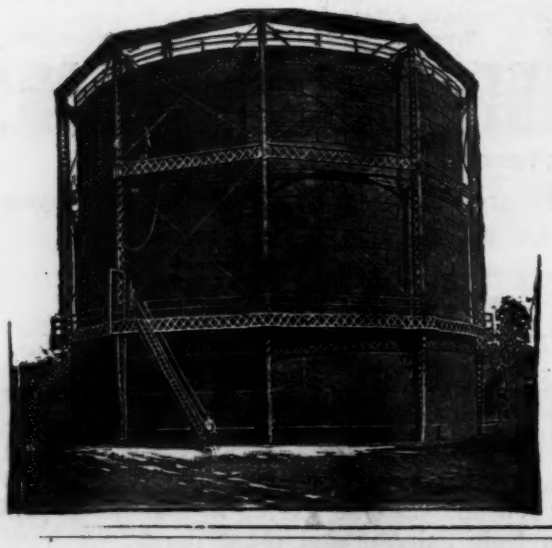

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Self-Sealing and Pressed Steel Mouthpiece Lids.

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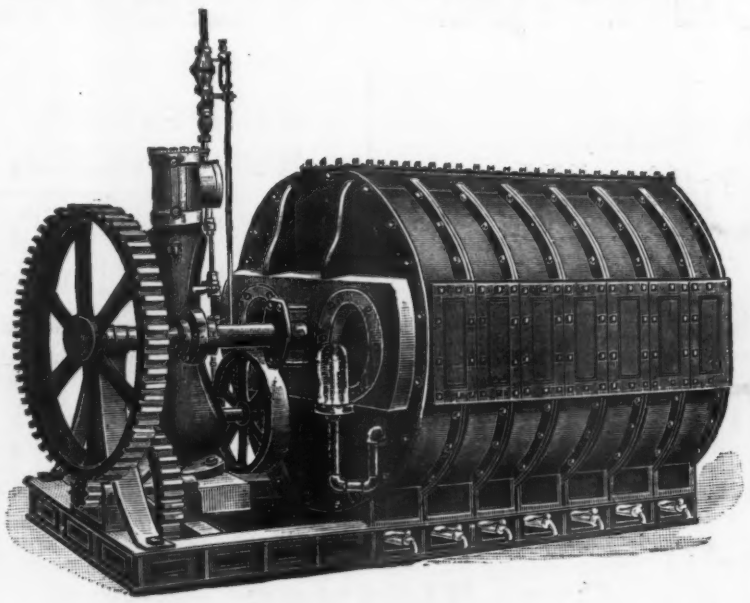

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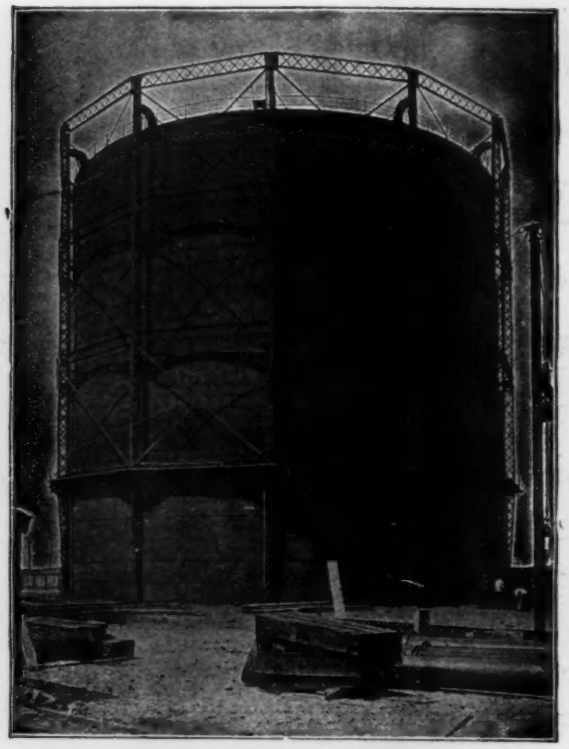

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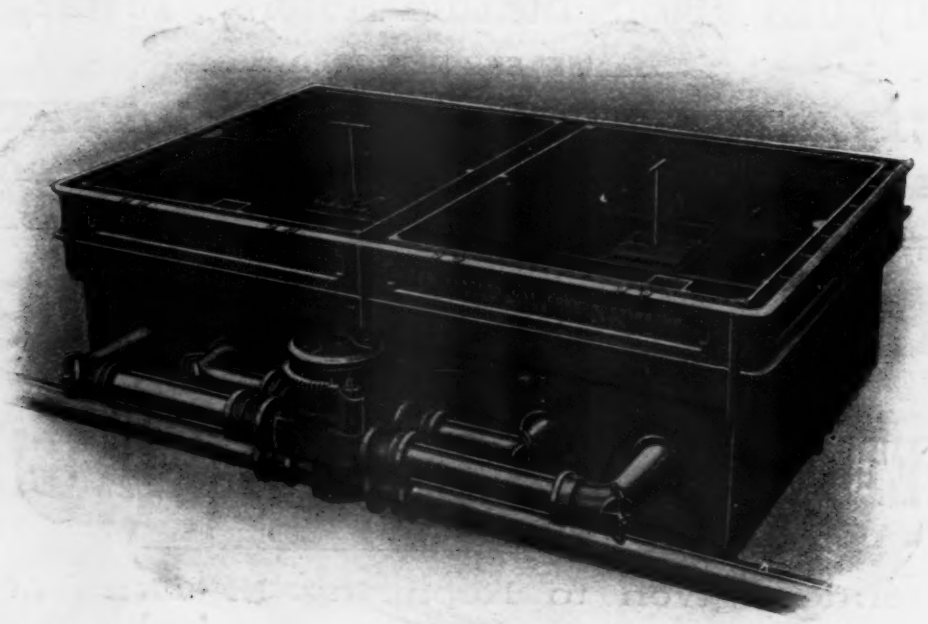

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